



## VOLUME 1

<u>Document/Contents</u>	<u>Date</u>	<u>Addressed to:</u>
Letter: Cost of vapor extraction pilot test at ECC and of carbon adsorption for vapor treatment for the remedial action.	02/04/88	Karen Vendl, Remedial Project Manager, USEPA
Document (submitted by Norman Bernstein): Settlement Remedial Action Plan Prepared in Response to the September 1987 Record-of Decision for the Environmental Conservation and Chemical Corporation (ECC) Site.	09/26/88	Karen Vendl, Remedial Project Manager, USEPA
Letter and document: Confidential Preliminary Draft for Settlement Purposes Only - Remedial Action Work Plan, Detailed Analysis - Environmental Conservation and Chemical Corporation (ECC) Site.	11/03/88	Elizabeth Maxwell, Office of General Counsel, USEPA
Letter and document: Exhibit A - Environmental Conservation and Chemical Corporation (ECC) Site.	12/07/88	Karen Vendl, Remedial Project Manager, USEPA
Letter and document: Conceptual Plan for the documents being prepared regarding the ECC site remediation.	12/08/88	Karen Vendl, Remedial Project Manager, USEPA
Document (hand-delivered): Proposed Clean-up Standards - Environmental Conservation and Chemical Corporation (ECC) Site.	02/24/89	Karen Vendl, Remedial Project Manager, USEPA, and John Buck, IDEM
Letter and document: Exhibit A - Environmental Conservation and Chemical Corporation (ECC) Site.	03/02/89	Karen Vendl, Remedial Project Manager, USEPA



**ERM-North Central, Inc.**  
Environmental Resources Management

102 Wilmot Road • Suite 300 • Deerfield, Illinois 60015 ☎ (312) 940-7200

February 4, 1988

Ms. Karen Vendl  
Remedial Project Manager  
U.S. Environmental Protection Agency  
Region V  
230 South Dearborn Street  
Chicago, IL 60604

RE: ECC Superfund Site

Dear Ms. Vendl:

In response to Ms. Maxwell's request to the ECC Steering Committee, I am providing additional information on the conceptual design of a vapor extraction system for the ECC site.

1. The cost of a pilot study to implement a vapor extraction system is estimated to be \$92,000.
2. The cost of a carbon adsorption system for treatment of the soil vapor prior to release is estimated to be \$220,000.

If we can provide any additional information, please let us know.

Very truly yours,

ERM-NORTH CENTRAL, INC.

*Roy Ball* / ERM

Roy O. Ball, Ph.D., P.E.  
Principal

rmw

cc: Norman W. Bernstein, Esquire  
Donald W. Smith

**SETTLEMENT REMEDIAL ACTION PLAN  
PREPARED IN RESPONSE TO THE  
SEPTEMBER 1987 RECORD OF DECISION  
FOR THE  
ENVIRONMENTAL CONSERVATION  
AND  
CHEMICAL CORPORATION (ECC) SITE  
ZIONSVILLE, INDIANA**

**SEPTEMBER 26, 1988**

**PREPARED FOR:**

**ECC SETTLERS STEERING COMMITTEE**

**PREPARED BY:**

**ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, ILLINOIS 60015**

**SETTLEMENT REMEDIAL ACTION PLAN  
PREPARED IN RESPONSE TO THE  
SEPTEMBER 1987 RECORD OF DECISION  
FOR THE  
ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION (ECC)  
SITE  
ZIONSVILLE, INDIANA**

**BACKGROUND**

To facilitate settlement and without waiver of any rights, Environmental Resources Management - North Central, Inc. (ERM) was retained by the ECC Settlers Steering Committee to prepare a Remedial Action Plan for the ECC site which meets the requirements of the plan described by the EPA in the September 1987 Record of Decision (ROD). The alternative remedial action plan presented herein (the Settlement Plan) addresses each of the environmental concerns associated with the ECC site, is cost effective, remediates observed contamination at the ECC Site in a complete and timely fashion, and most closely complies with SARA requirements since it involves on-site destruction of contamination.

**EPA'S REMEDIAL ACTION PLAN (THE EPA PLAN)**

The major components of the EPA Plan include:

- o Access control and monitoring,
- o A RCRA Performance Cap,
- o Ground water interception and collection,



- o Ground water treatment with an on-site facility.

The components of the EPA Plan are intended to address the contaminated soil at the ECC Site as well as contaminated ground water in the saturated till beneath the site. The ECC site presently has a surface runoff discharge point at the southern end of the property, which is an overflow from a sump installed by EPA as part of its emergency response actions at the ECC site.

#### **ECC SETTLER'S REMEDIAL ACTION PLAN (THE SETTLEMENT PLAN)**

The major components of the Settlement Plan include:

- o Access restrictions
- o Ground water and surface water monitoring
- o Diversion of surface water runoff upgradient of concrete pad
- o Collection of contaminated water from beneath the concrete pad
- o Shallow, saturated zone ground water interception and collection
- o Soil vapor extraction, preconcentration and destruction (carbon adsorption and thermal destruction)
- o Soil cover

The primary, active remediation component of the Settlement Plan is soil vapor extraction. The ECC Settlers Steering Committee has solicited opinions from consultants, notably Terra Vac, regarding the suitability of vapor extraction for the ECC site. Terra Vac, a recognized leader in soil vapor extraction and a contractor chosen by the USEPA for vapor extraction remediation, has conducted a pilot-test at the site and the results of that test (Attachments 1 & 2) demonstrate that vapor extraction is a viable and effective alternative for the ECC site. The current estimate is that vapor extraction will be operated for approximately one year to achieve clean-up limits. A more accurate estimate can be provided once residual concentrations, based on risk, have been established.

The ECC Settlers Steering Committee is confident that the settlement response measures listed above will fully address all necessary remedial actions for the ECC site. This proposed plan incorporates, elaborates and expands on the conceptual remedies proposed previously by the ECC Settlers Steering Committee (letter to Ms. Karen Vendl of USEPA from ERM-North Central dated May 19, 1987) and responds to the concerns raised by Mr. Basil Constantelos in his letter of February 10, 1988 to the ECC Technical Committee. Furthermore, the Settlement Plan is the plan that best meets SARA objectives.

This proposed remedial action plan covers remedial action at the ECC site only, however, a significant amount of coordination with the NSL remediation design and construction will be required. Nevertheless, this proposed remedy is fully compatible with the Northside Landfill (NSL) Steering Committee's Proposed Alternative Remedy presented to the EPA on February 12 1988, which we support. The ECC site is physically and chemically distinct from the NSL site, and physically distinct and separate from the new source of contamination (the Finley Creek Source) that was discovered and initially investigated by ERM for the ECC

Settlers Steering Committee. Although chlorinated solvents were detected at the Finley Creek Source, a careful review of aerial photographs and analysis of the available hydrogeological data indicate that the area is physically distinct from the ECC site, that the contamination does not result from the transport of contaminants from the ECC site, and that this contamination is a separate source from the ECC and NSL sites.

#### **DESCRIPTION OF THE SETTLEMENT PLAN**

Conceptually, the Settlement Plan consists of 7 components as previously listed. A detailed description of each component is presented below and the components are illustrated on Figures 1 and 2.

##### **1) Access Restrictions**

Deed restrictions would be placed on the ECC site. The restrictions should prevent future development of the land to protect against direct contact with contaminants or further migration that could result from site excavation and development. The deed restrictions should also prohibit the use of ground water or installation of wells on-site in both the saturated till and the underlying sand and gravel. The ground water use restrictions would also extend to areas where utilization of the shallow ground water would result in contamination drawn to those locations. Access to the ECC Site would be controlled by fencing around the site perimeter and the posting of signs.

##### **2) Ground Water and Surface Water Monitoring Program**

The effectiveness of the Settlement Plan will be assessed through a ground water and surface water monitoring program. Ground water would be monitored at three (3) monitoring wells located

downgradient of the southern limit of the ECC property (Figure 1). The wells would be installed in the sand and gravel unit underlying the near surface till. The wells would be sampled quarterly the first year and analyzed for parameters on the Target Compound List (TCL). The sampling frequency and analysis parameters for subsequent sampling will be determined after review of the first year data. Surface water would be sampled at the same frequency at the sampling location shown on Figure 1 and analyzed for the same parameters as the monitoring wells. The duration of ground water and surface water monitoring will be continued beyond the operational period of the active remedial system based on analytical data from the monitoring wells.

### **3) Diversion of Surface Water Runoff Upgradient of Concrete Pad**

Because an interim soil cap has been placed over the site, the only known source of contaminants to surface runoff is the subgrade material beneath the concrete pad on the southern end of the ECC site. According to the RI for the ECC site, surface water runoff from the northern part of the site largely flows south where a berm along the north edge of the concrete pad redirects runoff to a drainage ditch west of the site. This berm will be repaired and/or reinforced to ensure that runoff is diverted and is not able to infiltrate beneath the pad. This will essentially eliminate the generation of contaminated runoff into the EPA-installed sump located at the south end of the pad.

### **4) Collection of Contaminated Surface Water Beneath the Concrete Pad**

As previously noted, surface water which infiltrates the concrete pad may become contaminated. A lined collection trench approximately 4 feet deep by 1 foot in width will be installed along the south and southeast portions of the concrete pad to collect potentially contaminated surface water (Figure 1). The

trench will drain to a holding tank. The collected water will be conveyed to the NSL pipeline for conveyance to the Indianapolis sewerage system for final treatment. Once the surface water diversion system described in 3, above, is installed, the amount of water flowing into this trench will be negligible.

#### **5) Ground Water Interception**

The ground water interception system will consist of a single french drain extending east-west south of the ECC site along the north side of the NSL access road (Figure 1). The drain will be approximately 230 feet in length, 4 feet in width and will extend an average of 10 feet beneath the surface (Figure 1). The purpose of the drain is to collect contaminated ground water, if any, from the glacial till. Using the hydrogeologic assumptions from the ECC Feasibility Study for the design of the french drain system, approximately 0.5 gallons per minute would flow to the drain. This water would be the combined volume of infiltration for the surface, flow through the till, and upward flow for the underlying sand and gravel. This water will be collected in the same holding tank as described in 4. Water collected would be conveyed to the NSL connection to the Indianapolis sewerage system for final treatment.

#### **6) Soil Vapor Extraction Preconcentration and Destruction (Carbon Adsorption and Thermal Destruction)**

A conceptual design and preliminary cost estimate memorandum is included as Attachment 3.

#### **7) Soil Cover**

A soil cover, using the highly impermeable native till, will be installed and compacted over the ECC site to prevent erosion and water ponding on-site. Prior to placing the till, the site would

be graded, to fill existing depressions, eliminate sharp grade changes and provide for site drainage. Vegetative cover will also be established to mitigate potential effects of erosion.

#### **SCHEDULE AND COST**

The estimated time required to complete design and implementation phases of the Settlement Plan is illustrated in Figure 3. This schedule is based on the number of weeks for a notice to proceed.

Estimated costs to implement the Settlement Plan are shown on Table 1.

TABLE 1  
PRELIMINARY COST ESTIMATES, SETTLEMENT  
REMEDIAL ACTION PLAN, ECC SITE

<u>Direct Capital Components</u>	<u>Quantity</u>	<u>Unit</u>	<u>Total</u>
1. Access Restrictions			
- fencing	2,100 LF.	\$ 12/LF	\$ 25,200
- misc. (Gates, Signs)	---	---	<u>2,500</u>
			27,700
2. Ground Water and Surface Water Monitoring			
- wells	3 EA.	5,000/EA.	\$ 15,000
- misc. (Sampling Equipment)	---	---	<u>1,500</u>
			16,500
3. Diversion of Surface Water Runoff Upgradient of Concrete Pad			
- misc. (Berm regrading/buildup etc.)	---	---	\$ 10,000
4. Collection of Residual Leachate Beneath the Concrete Pad			
- excavate trench	110 CY	8/CY	\$ 880
- line trench (geotextile)	4,000 SF	0.17	680
- perforated pipe	365 LF	6/LF	2,190
- gravel backfill	100 CY	15/CY	1,500
- sump station	1 EA.	2,000/EA.	2,000
- holding tank	1 EA.	2,000/EA.	<u>2,000</u>
			9,250
5. Ground Water Interception			
- excavate trench	500 CY	10/CY	\$ 5,000
- liner, piping, etc.	---	---	4,000
- gravel backfill	500 CY	15/CY	7,500
- wet well, sump pump	---	---	5,000
- holding tank	1 EA.	10,000/EA.	<u>10,000</u>
			31,000

TABLE 1 (cont)  
PRELIMINARY COST ESTIMATES, SETTLEMENT  
REMEDIAL ACTION PLAN, ECC SITE

<u>Direct Capital Components</u>	<u>Quantity</u>	<u>Unit</u>	<u>Total</u>
6. Soil Vapor Extraction and Treatment			
- site preparation	---	---	\$ 20,000
- trench construction	---	---	0
- vapor extraction water piping	3500 L.F.	\$ 20/L.F.	70,000
- trench backfill and capping	2000 CU.YD.	\$ 20/CU.YD	40,000
- vapor extraction manifold system	300 L.F.	\$ 50/L.F.	15,000
- vapor extraction blower, motor, controls	---	---	100,000
- exhaust vapor preconcentration and destruction	---	---	50,000
- exhaust vapor stack and monitoring	---	---	<u>30,000</u>
			325,000

7. Soil Cap

- clay layer excavation and placement	---	---	185,000
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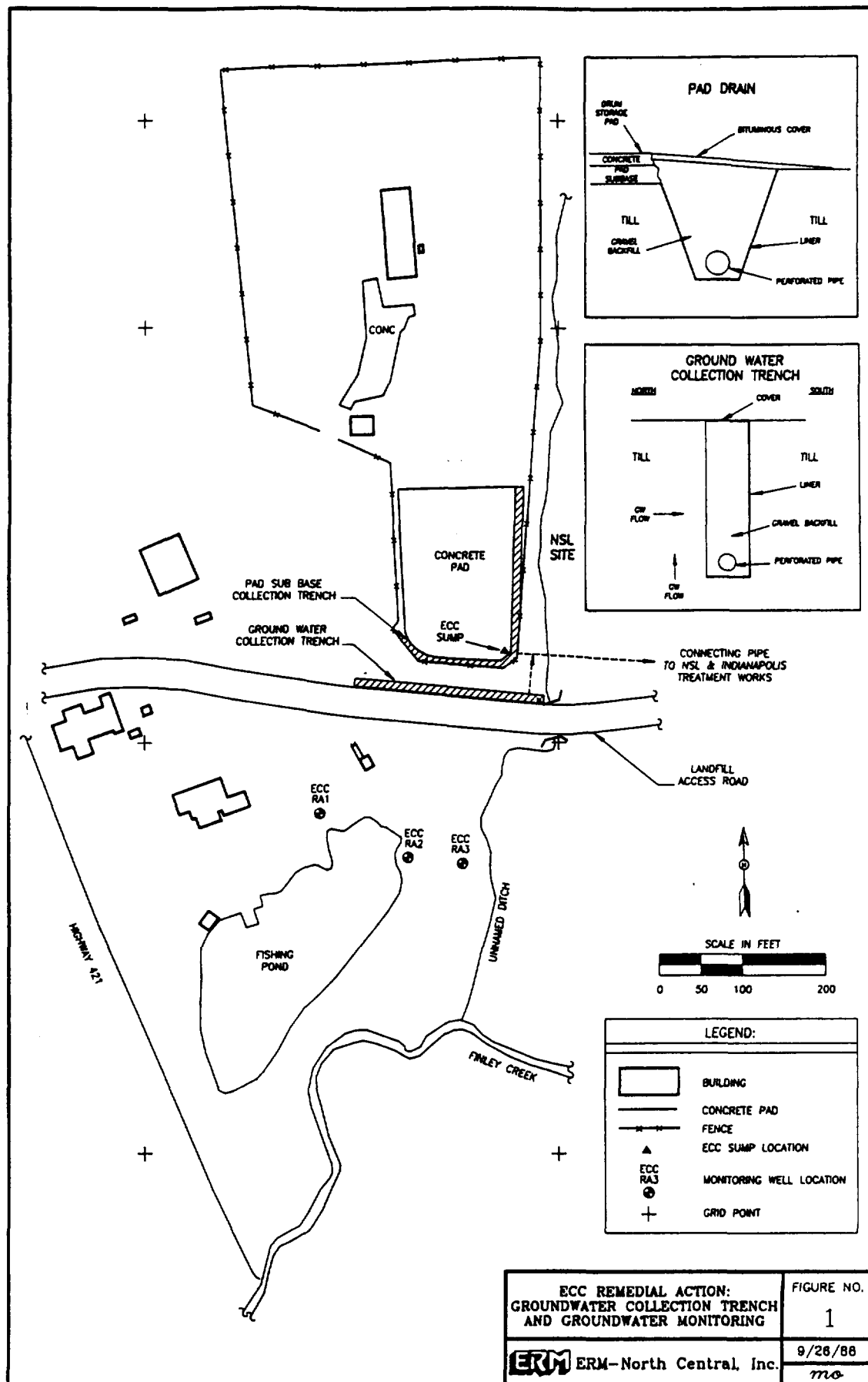
Sub-Total: Direct Capital Costs:	\$ 604,450
20% Engineer/Design:	121,000
25% Contingency:	<u>181,000</u>
TOTAL CAPITAL COSTS:	\$ 906,450

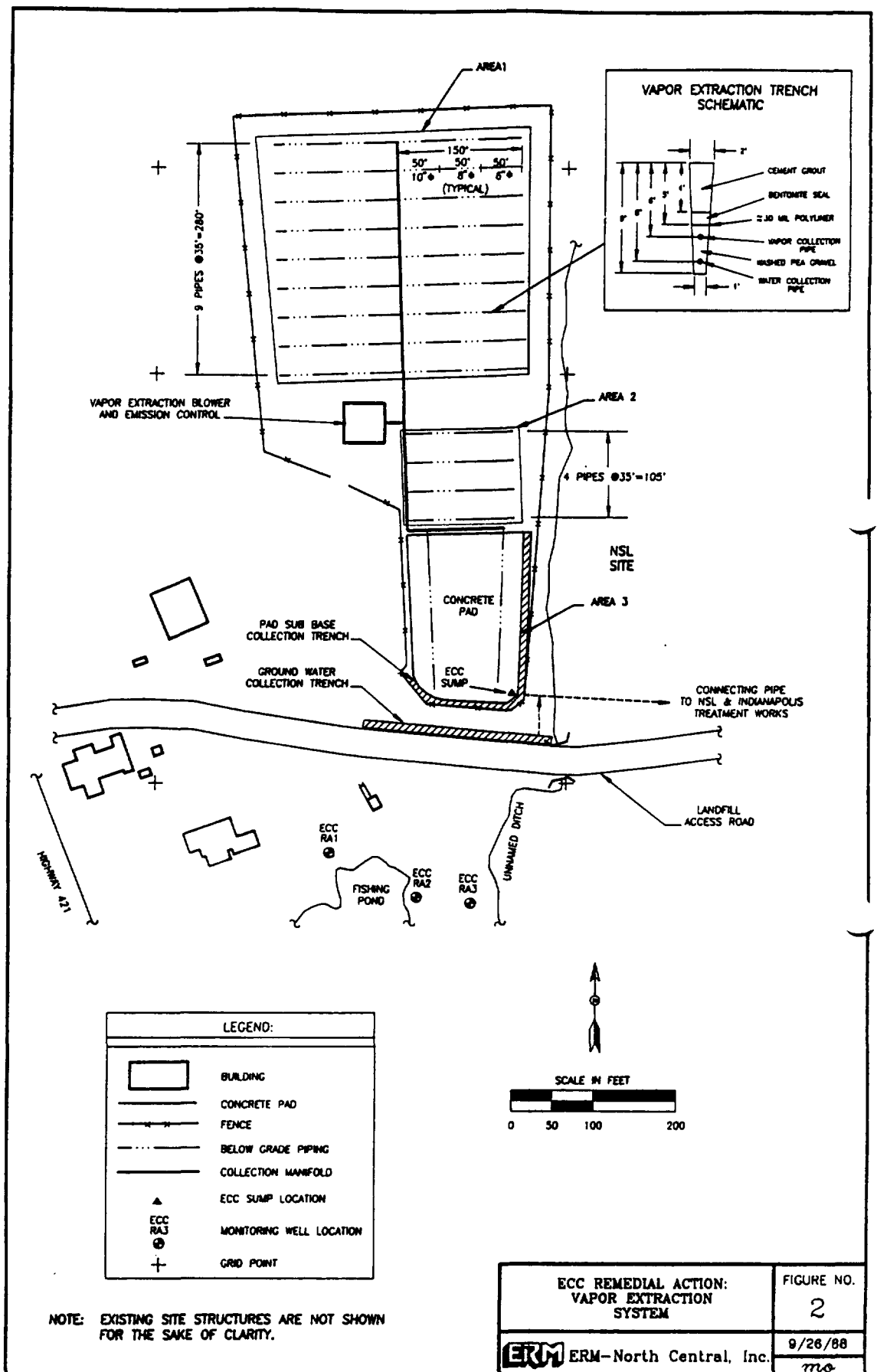
Operations and Maintenance Components

	<u>Cost for Year 1</u>	<u>Annual Cost Year 2</u>
1. Access Restrictions	\$ 5,000	\$ 5,000
2. Ground Water and Surface Water Monitoring System	20,000	20,000
3. Diversion of Surface Water Runoff Beneath Concrete Pad	2,000	2,000
4. Collection of Residual Leachate Beneath Concrete Pad	4,000	4,000
5. Ground Water Interception	7,500	7,500
6. Soil Vapor Extraction and Treatment *	868,000	---
7. Soil Cap	<u>10,000</u>	<u>10,000</u>
	\$ 916,500	\$ 48,500

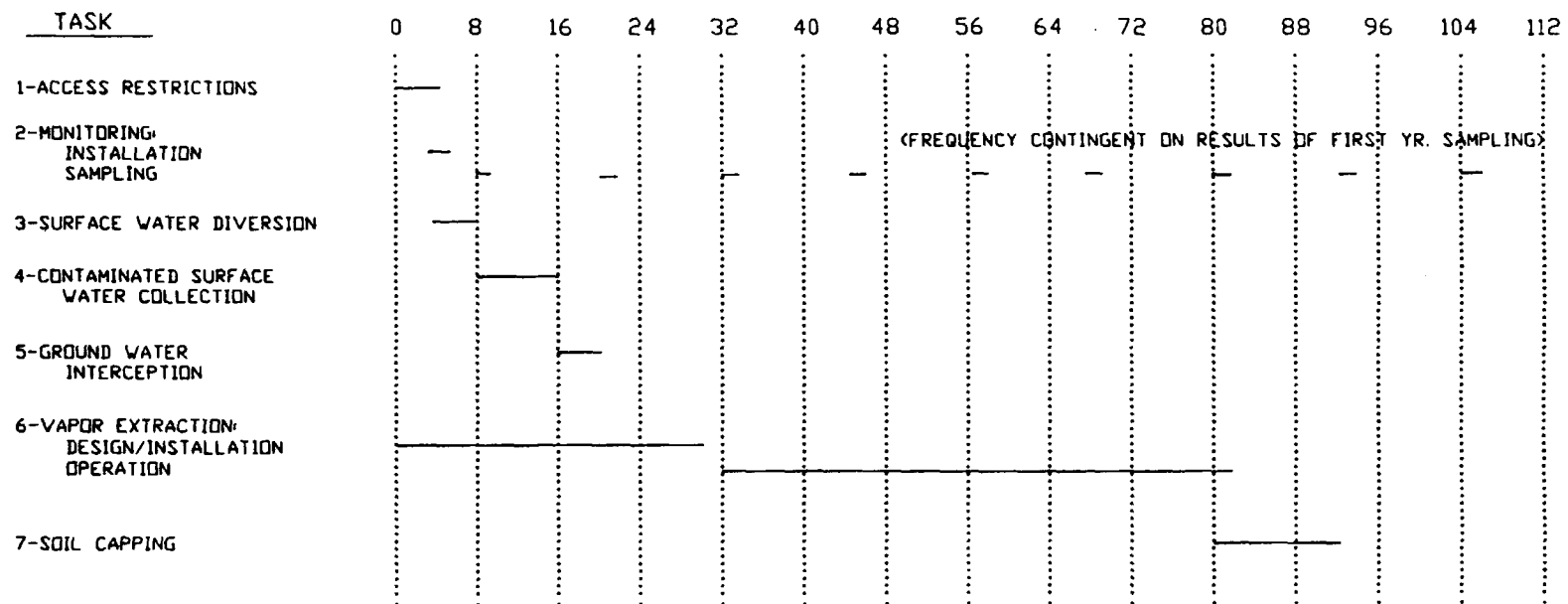
\* Anticipated operation of 1 year for vapor extraction system.







ESTIMATED PROJECT SCHEDULE  
 INSTALLATION OF  
 ECC SETTLEMENT REMEDIAL ACTION PLAN  
 WEEKS FROM EFFECTIVE DATE OF PLAN APPROVAL



<b>ERM</b> ERM-North Central, Inc.	ECC SITE ESTIMATED PROJECT SCHEDULE ECC SETTLEMENT PLAN INSTALLATION	FIGURE NO.
		3 8/30/88 mo

**ATTACHMENT 1**

**INTERIM REPORT  
OF  
VAPOR EXTRACTION PILOT TEST**

**JULY 8, 1988**

**PREPARED BY:**

**ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, IL 60015**

## INTRODUCTION

Vapor extraction is a process used to remove volatile organics from contaminated soils. The process works by withdrawing volatile contaminants from soil, in-situ. A subsurface vacuum is propagated from extraction wells or an extraction trench which causes vapors to migrate to the extraction wells or trench. The vapors are brought from the wells or trench to the surface where they are vented and destroyed by on-site catalytic incineration (except during the pilot test).

Terra Vac, Inc. is currently conducting a soil vapor extraction pilot test at the Envirochem site (ECC), near Zionsville, IN. Data from the pilot test is to be used to determine the feasibility and the cost of a full-scale vapor extraction system at the site.

## INSTALLATION OF THE PILOT TEST VAPOR EXTRACTION SYSTEM

Mobilization of Terra Vac, Inc. to the site began on May 31, 1988. The installation operations of a vapor extraction pilot test system started on June 7. Two 40-foot trenches (HEW 1 and HEW 2, See Figure 1-1) were excavated to a depth of 9 feet. At this depth, a small amount of water (<2 gals) was encountered in the east trench (HEW-1). A dark brown separate phase was noted on the water's surface in de minimus quantity (photograph will be forwarded).

Both trenches were backfilled with pea gravel to the 8-foot level. A four-inch PVC screen was installed along the entire length of each trench. A four-inch PVC riser pipe was connected at each end of the screen and extended above the top of the trench. The trenches were then backfilled with pea gravel to the 5-foot level. A second layer of PVC screen was placed at the 5-

foot depth. The trenches were then backfilled with pea gravel to the 3-foot level. A six-inch layer of wetted-powdered bentonite seal was placed followed by grout to grade level.

The lower pipe (at the 8-foot depth) was installed to collect any ground water that collected in the trench. This lower pipe was not connected to the vapor extraction system. Although no ground water has accumulated since installation (due to drought conditions) we intend to attempt to collect representative samples of ground water for characterization with respect to ultimate discharge to the City of Indianapolis.

The upper pipe is used in the vapor extraction system process. The riser pipe is connected to a pipe at the surface. This pipe leads to the water extraction system, then to the pump where the vapors are vented. Emission controls were not used during the pilot test due to the low emission levels in the vented soil vapors as determined by ambient monitoring.<sup>1</sup>

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<sup>1</sup> Since starting up, the system has been continually monitored by Terra Vac, Inc. using an on-site gas chromatograph. Vapor samples are collected at several points within the flowline and at the exhaust stack. Vapor samples were analyzed approximately every two hours during startup. The sampling frequency was reduced later in the test to approximately once/day. Data from the piezometers were also obtained for use in calculating the zone of influence.

During the system's operation, the site ambient air was monitored by ERM using a Photovac tip. The monitoring points (AM 1-1 through AM 2-9) enclosed the pilot test area as shown in Figure 1-2. Initially, the points were monitored on an hourly basis. Values up to 2.5 ppm above background were noted along the outer circumference. The concentrations measured along the outer circumference were well below the 5 ppm action level confirming that no potential health hazards to neighboring residents existed during the pilot test.

Ten piezometer wells were installed to monitor the system (Figure 1-1). Four of the piezometers (VM-1 to VM-4) were drilled and installed by Engineering and Testing Services, Inc. (ETS) of Indianapolis. ETS also drilled and installed a vertical extraction well (VE-1) which Terra Vac, Inc. intends to use to compare the efficiency of vertical to horizontal collection. The additional six piezometers (KVM-5 to KVM-10) were drilled and installed by Terra Vac, Inc. utilizing a hand drill.

Soil samples were collected during all phases of the trenching and drilling operations. A headspace analysis was performed on each soil sample utilizing an on-site gas chromatograph. Headspace concentrations ranged from 100 - 400 ppm. The main compounds identified included: DCA, DCE, TCE, toluene, PCE, and xylene. During the trenching and drilling operations, the work area was constantly monitored for ambient organic vapors by ERM-North Central personnel, utilizing a Photovac tip. Values obtained did not exceed the 5.0 ppm action level negotiated with IDEM for personnel safety protection upgrading.

#### PILOT TEST OPERATION

Development of the vapor extraction system started on June 13, 1988. The system has since operated continuously, except during brief shut-down periods for maintenance.

#### PERFORMANCE ANALYSIS

Based on data provided by Mike Disabato of Terra Vac on June 24, 1988, (a copy of which is attached as Appendix A) ERM-North Central has calculated the performance score of the vapor extraction technology using the results of the pilot test being



conducted at ECC. The calculations presented below follow the procedure described in our technical memorandum "Site Specific Evaluation of Vapor Extraction Application"<sup>2</sup> and are based upon data collected through June 17, 1988.

#### Horizontal Extraction Well No. 2

Trench dimensions: 40 ft long x 1 foot wide x 9 feet deep.

Soil total VOCs concentration: range from 100 to 400 ppm.

Zone of influence: 15 feet (30 feet wide).

Extraction rate at time of development: 57 pounds per day.

Utilizing the above information, the soil mass affected by the vapor extraction pilot test is approximately 40 ft x 30 ft x 9 ft, which equals 400 cubic yards. Assuming 1.5 tons per cubic yard, this equates to  $1.2 \times 10^6$  pounds of soil. Based on the RI data, 400 ppm was conservatively assumed as the initial VOCs concentration for the entire soil mass. This is equivalent to 480 pounds of VOCs in the affected soil mass. Therefore, with an extraction rate of 57 pounds per day when the trench was developed, the initial contaminant mass extraction rate is 11.9 percent per day.

The vapor extraction technology performance is rated as follows, utilizing Table 2 in the previously referenced "Site Specific Evaluation of Vapor Extraction":

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<sup>2</sup> Letter from ERM to Karen Vendl, USEPA, April 27, 1988

- The zone of influence (weighting factor of 3) receives a score of 60, since the materials excavated are predominantly clays and the zone of influence is 15 feet.
- The initial contaminant mass extraction rate (weighting factor of 2) receives a score of 80, since the removal is greater than 5 percent of the total concentration within the mass contained in the zone of influence.
- Finally, to be conservative, it is assumed that emission controls (weighting factor of 1) will be required during initial remediation, resulting in a score of 60.

These scores are then multiplied by their weighting factors, added, and divided by 6 to calculate an average performance score of 66.67 for Horizontal Extraction Well No. 2. If no emission controls are required during full-scale operation, the resultant performance score would be 70.

#### Horizontal Extraction Well No. 1

Similar calculations were carried out for Horizontal Extraction Well No. 1 for the same time period. The pertinent data are shown below:

Trench dimensions: 40 ft long x 1 ft wide x 9 ft deep.

Soil total VOCs concentration: ranged from 10 to 20 ppm.

Zone of Influence: 15 feet (30 feet wide).

Extraction rate at the time of development: 15 pounds per day.

Calculated similarly to Horizontal Extraction Well No. 2, 200 ppm was conservatively assumed for this area as the average concentration (based on the RI data). The initial VOC mass within the affected soil is 200 pounds, and the initial contaminant mass extraction rate equals six percent. Therefore, utilizing Table 2 to score the performance of Horizontal Extraction Well No. 1, the zone of influence receives a score of 60, the initial contaminant mass extraction rate receives a score of 80, and the emission controls receive a score of 60 with controls during initial remediation and a score of 80 with no controls. The resultant performance scores are 66.67 and 70, with and without controls, respectively.

Referring to Figure 1 of the previously referenced "Site Specific Evaluation for Vapor Extraction Application," a score of 60 or greater is necessary to implement vapor extraction and to proceed with the preliminary design and engineering. Based on the initial results from the pilot test, the performance of the system exceeds the criteria for a recommendation to the design phase.

#### VAPOR EXTRACTION PILOT TEST EXTENSION

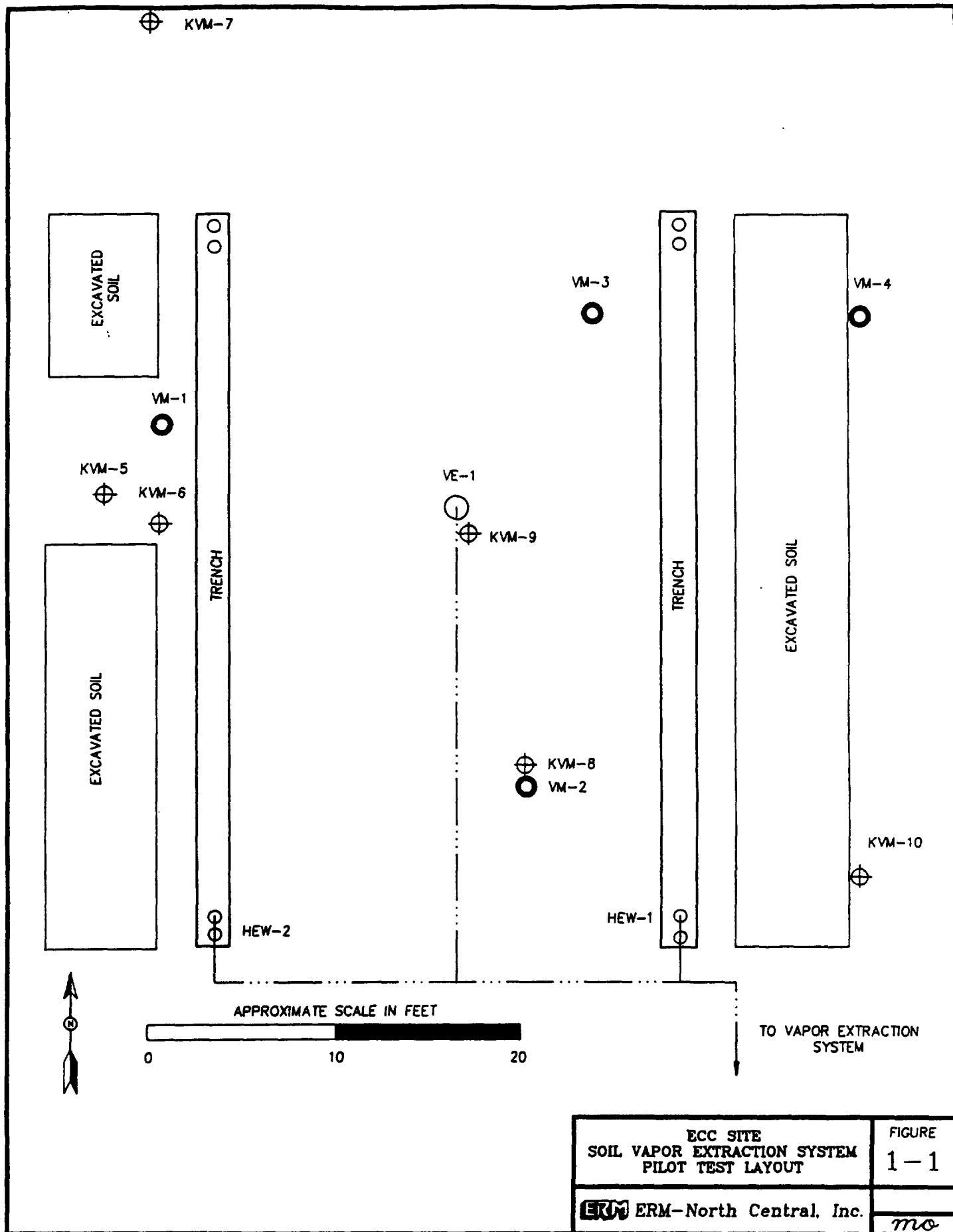
The pilot test has been extended for an additional 4 weeks, starting July 1, 1988. The pilot test was extended to better define the expected duration of operation of a full-scale soil vapor extraction system and the associated cost.

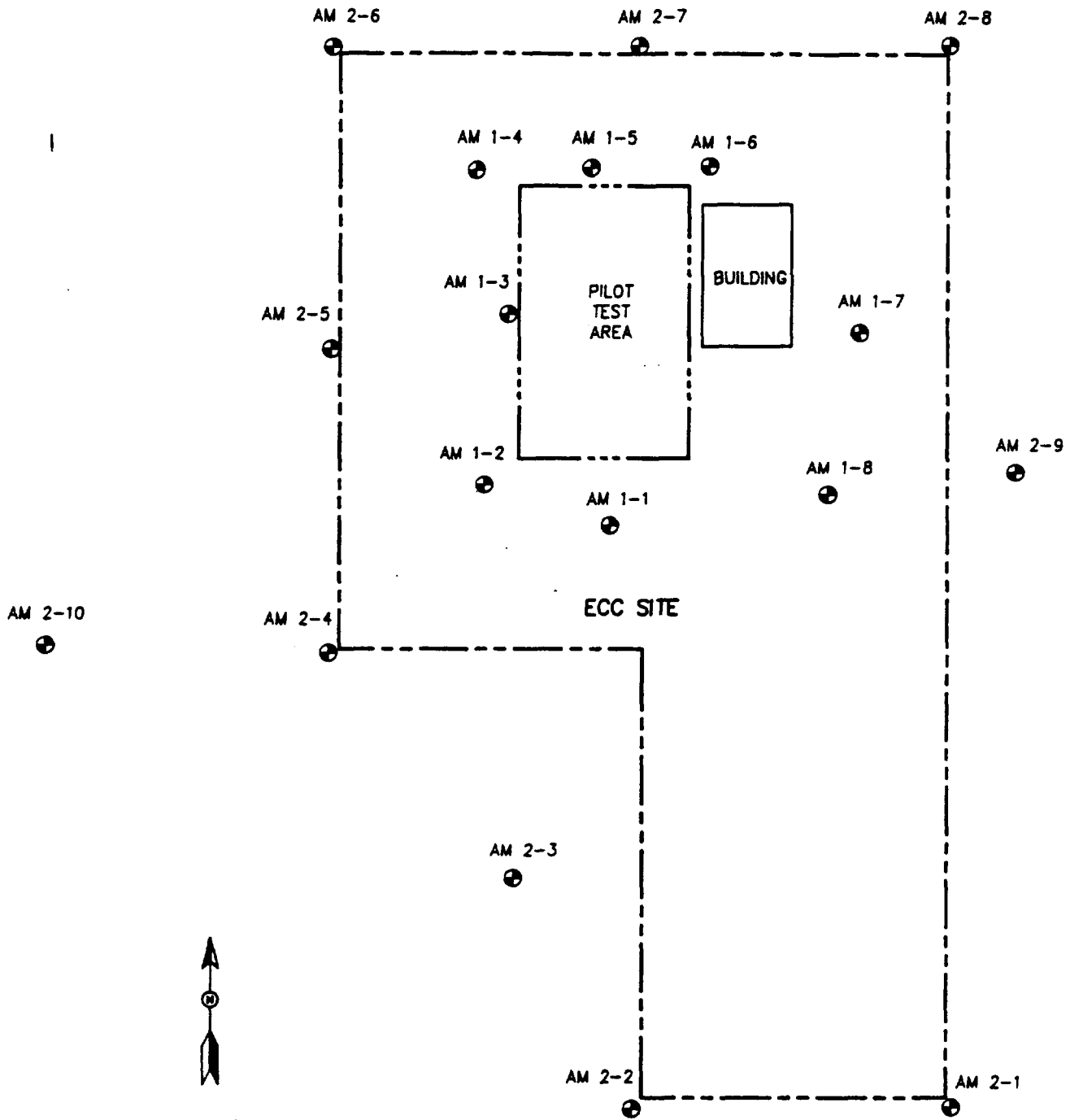
Samples will be collected by ETS 3 times/wk during the extended test period (a total of 12 additional samples) and sent to Terra Vac for GC analysis. ETS will continue to perform ambient site monitoring during sampling. ERM will visit the site once each week to confirm that the sampling and maintenance duties are being performed by ETS. ERM will also confirm that the vapor emissions remain below the action level. The on-site trailer will remain for the extended test.

#### SUMMARY

A vapor extraction pilot test has been conducted by Terra Vac at the ECC site. Based on data received and the criteria previously set, the vapor extraction system is successful in achieving the necessary reduction in VOC concentrations at the ECC site. The pilot test has been extended for an additional four week period. The benefits of the longer test and the associated expanded data base include:

- o improved prediction of the zone of influence
- o enhanced prediction of the steady-state rate of vapor extraction and soil treatment
- o improved design criteria and confidence level for size, duration and cost of operation.





ECC SITE  
AIR MONITORING LOCATIONS

ERM ERM-North Central, Inc.

FIGURE

1-2

**APPENDIX A**  
**TERRA VAC DATA**

Date: 7/5/88

Deliver to: Paul Kopydlowski

Company: ERM

FAX #: 312-940-9280

From: Tony Dall

Company: TERRA VAC                      SAN FRANCISCO OFFICE  
14204 Doolittle Drive  
San Leandro, CA 94577  
(415) 351-8900

FAX #: (415) 351-0221

FAX Type: Group III

Total number of pages including this cover letter: 6

Description of Contents: Operations and sample data at  
ECC site up to + incl 6/27 (preliminary data)

Message: Note: Sample volume and flow changes must be  
considered ~~also~~ in conjunction with GC record of concentrations.

\* Approximately 300 lbs VOCs removed as of 6/27.

\* Daily rates increase with initial development, then  
start to decline.

\* Highest outer perimeter air rdy = 2.5 ppm with wind  
coming across NSL.

Highest inner perimeter air rdy = 1.5 ppm.

NO WATER



ECC SOILS DATA  
TERRA VAC PILOT TEST

=====									
4 & VE-1	VM-1.2.3.4 & VE-1				VM-1.2.3.4 & VE-1				
===== SOIL CONCENTRATION (PPM) =====					===== SOIL CONCENTRATION (PPM) =====				
DEPT	DCE	TCA	BZ	TCE	TOL	PCE	mp-XYL	TOTAL	
FT.	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm	
-----									
1-13	3.0	.5	2.9	.0	.7	1.0	.0	.1	11.3
1-16	6.0	.3	11.8	.0	5.9	.2	.0	.0	18.2
2-3	3.0	2.2	26.2	.0	74.6	6.2	65.4	1.7	176.4
2-6	6.0	1.0	14.9	.0	2.3	.5	8.3	.1	27.0
3-3	3.0	.0	3.6	.0	.1	.7	.0	.0	4.4
3-5	5.0	.4	2.2	.0	10.8	.5	3.1	.0	23.7
4-3	3.0	1.6	1.7	.0	.8	.0	.9	.0	5.1
4-6	6.0	2.5	17.1	.0	10.7	1.2	2.0	.0	33.5
5-3	3.0	2.8	128.5	.0	80.5	5.9	1.5	1.8	220.9
6-17L	6.0	12.5	90.2	.0	232.5	8.7	47.4	1.9	393.3
1-19	9.0	.0	.0	.0	.1	.0	.0	.0	.1

TERRA VAC/ ECC - E

XX																
XX UE-1										UE-1						
XX																
SAMPLE TIME		XX	<< OPERATION DATA >>						11	<< GAS CHROMATOGRAPH READOUT >>					11	
		XX	INJ		WELL	FLOW	FLOW	11	1,1	1,1,1	M,P- TOTAL				11	
		XX	SAMP	VOL	VAC	RATE	RATE	11	DCE	TCA	TCE	TOL	PCE	XYL AREA	11	
DATE	HRS MIN	XX	NUM	(u1)	(H <sub>2</sub> )	(SCFM)	(ACFM)	11	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	(mg/l)	1000X	11
-----																
Jun-14	12 17	XX	888					11							0	11
Jun-14	12 18	XX	888	100	1.0			11							0	11
Jun-14	12 38	XX	888	100	1.0			11							0	11
Jun-14	13 18	XX	888	100	1.0			11							0	11
Jun-14	13 31	XX	888	100	1.0			11							0	11
Jun-14	14 31	XX	888	100	1.0			11							0	11
Jun-14	15 31	XX	888	100	1.0			11							0	11
Jun-14	15 40	XX	888	100	1.0			11							0	11
Jun-14	16 29	XX	888	100	1.0			11							0	11
Jun-14	17 29	XX	888	100	1.0			11							0	11
Jun-14	20 42	XX	888	100	1.0			11							0	11
Jun-15	8 39	XX	888	100	1.0			11							0	11
Jun-15	9 20	XX	888	100	1.0			11							0	11
Jun-15	11 30	XX	888	100	1.0			11							0	11
Jun-15	12 10	XX	777	100	8.8			11							0	11
Jun-15	12 23	XX	113	100	9.0	4	511		.606	1.501	2.584	.059	.267	.007	1045	11
Jun-15	12 27	XX	999	100	8.8	4	511									11
Jun-15	14 50	XX	116	100	9.0	4	511		.078	.782	.558	.072	.082	.020	490	11
Jun-15	15 55	XX	999	100	9.0	8	1011									11
Jun-15	16 2	XX	999	100	9.0	8	1011									11
Jun-16	10 48	XX	999	100	8.5	13	1511									11
Jun-16	13 6	XX	121	100	8.0	13	1511		.008	.065	.030	.016	.008	.003	61	11
Jun-16	15 45	XX	999	100	1.0	15	1511									11
Jun-16	16 30	XX	888	100	1.0	15	1511									11
Jun-16	19 15	XX	777	100	1.0	15	1511									11
Jun-17	10 45	XX	126	100	8.8	17	2011		.016	.081	.082	.012	.015	.003	68	11
Jun-17	11 0	XX	888	100	1.0		11									11
Jun-17	11 40	XX	777	100	1.0		11									11
Jun-17	15 0	XX	128	500	10.0	4	511		.053	.339	.213	.070	.041	.017	280	11
Jun-18	10 0	XX	132	500	7.8	4	511		.049	.339	.215	.061	.044	.016	256	11
Jun-19	10 30	XX	135	500	7.1	4	511		.038	.424	.256	.055	.048	.017	296	11
Jun-19	10 47	XX	888	100	1.0		11									11
Jun-19	11 40	XX	888	100	1.0		11									11
Jun-20	9 20	XX	888	100	1.0		11									11
Jun-20	9 50	XX	888	100	1.0		11									11
Jun-20	10 35	XX	888	100	1.0		11									11
Jun-20	15 0	XX	888	100	1.0		11									11
Jun-21	9 0	XX	888	100	1.0		11									11
Jun-21	9 33	XX	888	100	1.0		11									11
Jun-21	10 30	XX	777	100	1.0		11									11
Jun-22	10 0	XX	140	500	14.6	4	511		.094	.588	.692	.047	.101	.017	364	11
Jun-22	16 10	XX	145	500	14.4	4	511		.081	.663	.690	.057	.124	.022	415	11
Jun-23	10 0	XX	146	500	14.5	4	511		.095	.899	.856	.071	.136	.032	556	11
Jun-24	11 0	XX	154	500	14.5	4	511		.019	.202	.211	.017	.033	.009	135	11
Jun-24	14 30	XX	888	500		5	511									11
Jun-24	16 34	XX	999	500	10.0	4	511									11
Jun-24	16 50	XX	999	500	8.7	4	511									11
Jun-24	17 35	XX	999	500	8.9	4	511									11
Jun-25	9 15	XX	999	500	8.0	4	511									11
Jun-27	11 30	XX	160	500	6.8	4	511		.026	.437	.290	.069	.041	.036	277	11
Jun-27	16 0	XX	888	500	6.8	4	511									11

*Preliminary data*

ECC SOILS DATA  
TERRA VAC PILOT TEST

HEW-1	HEW-1	HEW-1	HEW-1	HEW-1	HEW-1	HEW-1	HEW-1	HEW-1
SOIL CONCENTRATION (PPM)								
DEPTH	DCE	TCA	BZ	TCE	TOL	PCE	mp-XYL	TOTAL
FT.	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
+3-3	3.0	.2	3.2	NA	7.7	1.9	4.5	19.4
1-6-7	7.0	.4	2.4	NA	4.5	2.1	9.6	9.4
6-9	9.0	.1	.0	NA	.0	.0	.1	.2
12-4	4.0	2.4	59.6	NA	99.7	5.1	187.5	166.7
12-7	7.0	4.5	63.9	NA	125.0	5.9	155.2	199.3
20-2	2.0	6.2	18.3	NA	59.0	10.6	2.4	94.5
25-7	7.0	3.9	3.8	NA	24.5	4.0	11.5	41.1
35-5	5.0	7.7	45.6	NA	7.9	4.6	4.0	65.7
35-6	6.0	62.3	96.2	NA	49.7	9.4	103.1	217.6
40-3	3.0	6.3	4.3	NA	2.0	.5	1.6	13.1
40-5	5.0	1.5	22.4	NA	2.6	1.0	1.1	27.5
40-7	7.0	.7	67.4	NA	9.0	6.9	1.9	84.1

HEW-2	HEW-2	HEW-2	HEW-2	HEW-2	HEW-2	HEW-2	HEW-2	HEW-2
SOIL CONCENTRATION (PPM)								
DEPTH	DCE	TCA	BZ	TCE	TOL	PCE	mp-XYL	TOTAL
FT.	ppm	ppm	ppm	ppm	ppm	ppm	ppm	ppm
2-5-3	3.0	.6	3.6	NA	6.5	3.3	1.5	14.0
5-7	7.0	1.1	180.8	NA	10.6	19.7	4.9	212.1
5-9	9.0	.2	5.1	NA	8.5	1.2	8.7	15.0
15-2	2.0	1.5	109.6	NA	6.8	15.3	2.1	133.2
15-8	8.0	1.1	83.0	NA	16.2	13.8	2.2	114.1
18-5	5.0	1.1	40.2	NA	12.0	.8	1.9	54.2
22-3	3.0	.4	54.7	NA	20.1	4.0	4.7	79.1
22-8	8.0	.1	1.8	NA	.7	.4	.2	3.0
35-3	3.0	1.6	37.9	NA	58.7	18.1	26.4	116.2
35-4	4.0	.6	54.5	NA	333.9	25.5	35.0	414.4
35-7	7.0	1.4	68.9	NA	71.3	19.2	20.6	160.7
40-5	5.0	2.5	153.5	NA	24.8	13.3	5.6	194.1
45-2	2.0	.9	68.9	NA	21.7	12.5	3.8	103.9
45-6	6.0	1.6	116.8	NA	15.4	14.1	2.5	147.8

T2-5-3 = HEW-2 sample, Spt from end of trench at 3 ft depth

TERRA VAC/ ECG - ERM

XX																
XX NEW-1										NEW-1						
XX																
SAMPLE TIME		XX	(( OPERATION DATA ))					XX	(( GAS CHROMATOGRAPH READOUT ))					XX		
		XX	INJ		WELL FLOW	FLOW	XX	1,1	1,1,1	M,P- TOTAL				XX		
		XX	SAMP	VOL	UAC	RATE	RATE	XX	DCE	TCA	TCE	TOL	PCE	XYL	AREA	XX
DATE	HRS MIN	XX	NUM	(ul)	(°Hg)	(SCFM)	(ACFM)	XX	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	1000X	XX
-----																
Jun-14	12 17	XX	888					XX								XX
Jun-14	12 18	XX	888	100	1.0			XX								XX
Jun-14	12 38	XX	888	100	1.0			XX								XX
Jun-14	13 18	XX	888	100	1.0			XX								XX
Jun-14	13 31	XX	888	100	1.0			XX								XX
Jun-14	14 31	XX	888	100	1.0			XX								XX
Jun-14	15 31	XX	888	100	1.0			XX								XX
Jun-14	15 40	XX	888	100	1.0			XX								XX
Jun-14	16 29	XX	888	100	1.0			XX								XX
Jun-14	17 29	XX	888	100	1.0			XX								XX
Jun-14	20 42	XX	888	100	1.0			XX								XX
Jun-15	8 39	XX	888	100	1.0			XX								XX
Jun-15	9 20	XX	888	100	1.0			XX								XX
Jun-15	11 30	XX	888	100	1.0			XX								XX
Jun-15	11	XX	888	100	1.0			XX								XX
Jun-15	12 23	XX	777	100	1.0			XX								XX
Jun-15	12 27	XX	114	100	8.5	2	2	XX	.377	1.380	.701	.034	1.015	.008	1210	XX
Jun-15	14 50	XX	115	100	9.5	17	20	XX	.040	.241	.107	.030	.170	.015	194	XX
Jun-15	15 55	XX	999	100	9.5	17	20	XX								XX
Jun-15	16 2	XX	999	100	9.5	25	30	XX								XX
Jun-16	10 48	XX	999	100	9.5	33	40	XX								XX
Jun-16	13 6	XX	122	100	8.8	34	40	XX	.012	.065	.027	.006	.049	.003	44	XX
Jun-16	15 45	XX	999	100	8.8	34	40	XX								XX
Jun-16	16 30	XX	888	100	1.0	39	40	XX								XX
Jun-16	19 15	XX	777	100	1.0	52	53	XX								XX
Jun-17	10 45	XX	124	100	8.4	68	80	XX	.009	.054	.022	.003	.036	.001	54	XX
Jun-17	11 0	XX	888	100	1.0			XX								XX
Jun-17	11 40	XX	777	100	1.0			XX								XX
Jun-17	15 0	XX	127	500	9.7	82	100	XX	.031	.227	.090	.018	.163	.007	158	XX
Jun-18	10 0	XX	131	500	7.2	90	103	XX	.022	.192	.085	.013	.130	.005	102	XX
Jun-19	10 30	XX	134	500	6.8	114	130	XX	.014	.187	.090	.012	.147	.004	152	XX
Jun-19	10 47	XX	888	100	1.0			XX								XX
Jun-19	11 40	XX	888	100	1.0			XX								XX
Jun-20	9 20	XX	888	100	1.0			XX								XX
Jun-20	9 50	XX	888	100	1.0			XX								XX
Jun-20	10 35	XX	777	100	1.0			XX								XX
Jun-20	15 0	XX	138	500	9.5	141	170	XX	.013	.161	.074	.011	.133	.004	78	XX
Jun-21	9 0	XX	139	1000	7.8	185	215	XX	.020	.291	.138	.023	.255	.009	179	XX
Jun-21	9 33	XX	888	100	1.0			XX								XX
Jun-21	10 30	XX	888	100	1.0			XX								XX
Jun-22	10 0	XX	888	100	1.0			XX								XX
Jun-22	16 10	XX	888	100	1.0			XX								XX
Jun-23	10 0	XX	888	100	1.0			XX								XX
Jun-24	11 0	XX	888	100	1.0			XX								XX
Jun-24	14 30	XX	888	100	1.0			XX								XX
Jun-24	16 34	XX	888	100	1.0			XX								XX
Jun-24	16 50	XX	888	100	1.0			XX								XX
Jun-24	17 35	XX	888	100	1.0			XX								XX
Jun-25	9 15	XX	888	100	1.0			XX								XX
Jun-27	11 30	XX	888	100	1.0			XX								XX
Jun-27	16 0	XX	888	100	1.0			XX								XX

*Preliminary data*

XX																
XX HEW-2				HEW-2												
XX																
SAMPLE TIME		XX	<< OPERATION DATA >>					11	<< GAS CHROMATOGRAPH READOUT >>					11		
		XX	INJ	WELL	FLOW	FLOW	11	1,1	1,1,1	M,P-				TOTAL	11	
		XX	SAMP	VOL	UAC	RATE	RATE	11	DCE	TCA	TCE	TOL	PCE	XYL	AREA	11
DATE	HRS	MIN	XX	NUM	(ul)	(°Hg)(SCFM)	(ACFM)	11	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	(ug/l)	1000X	11
=====																
Jun-14	12	17	XX	777				11							0	11
Jun-14	12	18	XX	106	100	10.0	4	5	.163	1.170	1.150	.094	.200	.019	1020	11
Jun-14	12	38	XX	107	100	10.0	4	5	.146	1.890	.863	.121	.109	.024	1105	11
Jun-14	13	18	XX	108	100	10.0	4	5	.162	1.870	.791	.129	.132	.031	930	11
Jun-14	13	31	XX	888	100	10.0	4	5								11
Jun-14	14	31	XX	777	100	10.0	4	5								11
Jun-14	15	31	XX	109	100	7.5	4	5	.128	2.216	.903	.171	.131	.048	990	11
Jun-14	15	40	XX	888	100	8.0	4	5								11
Jun-14	16	29	XX	777	100	9.0	4	5								11
Jun-14	17	29	XX	110	100	8.5	8	10	.103	1.953	.915	.182	.138	.057	928	11
Jun-14	20	42	XX	111	100	9.0	8	10	.077	1.328	.823	.152	.130	.051	728	11
Jun-15	8	39	XX	888	100	9.3	17	20								11
Jun-15	9	20	XX	777	100	9.0	17	20								11
Jun-15	11	30	XX	112	100	9.0	17	20	.046	.724	.626	.104	.104	.036	475	11
Jun-15	12	10	XX	999	100	10.0	16	20								11
Jun-15	12	23	XX	999	100	10.0	16	20								11
Jun-15	12	27	XX	999	100	9.0	17	20								11
Jun-15	14	50	XX	999	100	8.5	17	20								11
Jun-15	15	55	XX	117	100	9.5	17	20	.036	.520	.491	.077	.084	.025	358	11
Jun-15	16	2	XX	999	100	8.5	25	30								11
Jun-16	10	48	XX	999	100	9.0	33	40								11
Jun-16	13	6	XX	120	100	9.1	38	45	.020	.266	.283	.042	.051	.012	191	11
Jun-16	15	45	XX	999	100	9.0	38	45								11
Jun-16	16	30	XX	888	100	1.0	44	45								11
Jun-16	19	15	XX	777	100	12.0	54	70								11
Jun-17	10	45	XX	125	100	7.8	106	123	.014	.134	.162	.021	.034	.007	143	11
Jun-17	11	0	XX	888	100	1.0	0									11
Jun-17	11	40	XX	777	100	1.0	0									11
Jun-17	15	0	XX	129	100	9.0	115	138	ND	.060	.081	.011	.018	.003	50	11
Jun-18	10	0	XX	133	500	6.3	146	164	.021	.232	.354	.054	.079	.019	223	11
Jun-19	10	30	XX	136	500	5.8	202	225	.012	.164	.271	.039	.050	.015	199	11
Jun-19	10	47	XX	888	100	1.0	0									11
Jun-19	11	40	XX	777	100	1.0	0									11
Jun-20	9	20	XX	137	500	7.0	210	240	nd	.115	.214	.032	.040	.012	188	11
Jun-20	9	50	XX	888	100	1.0	0									11
Jun-20	10	35	XX	888	100	1.0	0									11
Jun-20	15	0	XX	888	100	1.0	0									11
Jun-21	9	0	XX	888	100	1.0	0									11
Jun-21	9	33	XX	888	100	1.0	0									11
Jun-21	10	30	XX	888	100	1.0	0									11
Jun-22	10	0	XX	888	100	1.0	0									11
Jun-22	16	10	XX	888	100	1.0	0									11
Jun-23	10	0	XX	888	100	1.0	0									11
Jun-24	11	0	XX	888	100	1.0	0									11
Jun-24	14	30	XX	888	100	1.0	0									11
Jun-24	16	34	XX	777	100	1.0	0									11
Jun-24	16	50	XX	155	500	7.2	205	235	.027	.551	.391	.067	.087	.028	377	11
Jun-24	17	35	XX	156	500	7.2	205	235	.020	.362	.333	.055	.072	.023	259	11
Jun-25	9	15	XX	157	500	5.9	233	260	.011	.135	.209	.030	.037	.012	184	11
Jun-27	11	30	XX	159	500	4.3	315	340	.006	.051	.118	.023	.020	.007	78	11
Jun-27	16	0	XX	160	1000	4.2	315	340	.012	.101	.244	.048	.040	.016	197	11

Preliminary data

**APPENDIX B**  
**SITE SPECIFIC EVALUATION OF VAPOR EXTRACTION**

## **SITE SPECIFIC EVALUATION OF VAPOR EXTRACTION APPLICATION**

### **INTRODUCTION**

Vapor extraction is a process used to remove volatile pollutants from contaminated soils (1,2,3,4). The process works by withdrawing volatile contaminants from soil, in situ. A subsurface vacuum is propagated from extraction wells which causes vapors to migrate to the extraction wells. The vapors are brought from the wells to the surface where they are collected and treated.

The effectiveness of the vapor extraction process is influenced by the contaminant volatility, the soil stratigraphy and the location of the ground water table. The implementation of vapor extraction therefore requires site specific evaluation. This report describes a procedure to evaluate the application of vapor extraction technology for a particular site.

### **SUMMARY OF METHODOLOGY**

A site investigation must be performed to determine the type, extent and severity of contamination. A CERCLA remedial investigation is generally sufficient for this purpose. Certain data collected from the site are scored and weighted to determine the feasibility of vapor extraction for the given site. Based on the calculated feasibility score, a decision is made either to reject vapor extraction for the site, to reevaluate alternative technologies, or to conduct a vapor extraction pilot test.

If site conditions (as defined by the feasibility score) are favorable, pilot tests are performed. Performance data from the

pilot test are then evaluated through a scoring and weighting procedure analogous to the feasibility scoring procedure. A decision is made either to reject the vapor extraction process as unsuitable for the site conditions, to reevaluate alternative technologies, or to affirm that the vapor extraction process can be applied to the site. The methodology is graphically depicted in Figure 1.

#### **SITE SPECIFIC DATA REQUIREMENTS**

Site remedial investigation activities provide the data needed to support decisions made in feasibility studies. Vapor extraction is dependent upon the ability of contaminants to volatilize and move through the soils to a collection system. A site characterization study must therefore define the types and extent of contamination on a site and the soil matrix in which the contaminants are found. Specifically, the site investigation must define the contaminants, their distribution and the soil classification on a site.

The site characterization study must also define the percent of total contamination in the unsaturated zone. If a significant portion of the total contaminant mass is contained in the saturated zone, the feasibility of dewatering must also be defined. Superfund site remedial investigation/feasibility studies typically provide the site characteristic data described above.

#### **FEASIBILITY ANALYSIS**

Assuming that the required data are available, a feasibility analysis is performed to determine if the vapor extraction process should be considered for a site. Initially the most



important concern is the volatility of the contaminants (2,5). The volatility of the compounds will determine their transport from the liquid phase as attached to soil particles to the vapor phase in the soil gas.

### Volatility

For evaluation purposes, volatility is indicated by Henry's Law constants. The use of adsorption isotherms to account for the soil/liquid interaction is desirable but adsorption coefficients are generally unavailable for most compounds and soil types (6). Contaminants with Henry's Law constants greater than  $10^{-4}$  (atm-m<sup>3</sup>/mol) are considered amenable to removal by vapor extraction. Compounds with Henry's Law constants less than  $10^{-7}$  should be considered essentially nonvolatile (7) and are poor candidates for evaporative technologies. Compounds with Henry's Law constants in the range of  $10^{-4}$  to  $10^{-7}$  are considered fair candidates for vapor extraction.

### Stratigraphy

The second factor of concern is the transport of vapor from the soil to the collection system. This transport is dependent on the vacuum developed on the site (which is a process operation parameter) and the characteristics of the soil. The movement of gasses in porous media is described by Darcy's Law (6). The coefficient of permeability used in Darcy's law to describe the transport of ground water through soil may be used to characterize the flow of other fluids through soil such as air or vapor. Soil permeability may be estimated based on a classification of the representative materials in the soil. Sandy soils which generally have a coefficient of permeability greater than  $10^{-3}$  (cm<sup>3</sup>/cm<sup>2</sup>/sec)(8) are good candidates for the use of the vapor extraction process. Mixed soils with coefficients of permeability between  $10^{-3}$  and  $10^{-6}$  are considered

fair candidates for the application of this technology. Soils with coefficients of permeability less than  $10^{-6}$  are considered poor candidates for the application of this technology.

#### Ground Water

The presence of ground water will inhibit the transport of volatile pollutants from the saturated soil matrix to the soil gas above. If 90% of the total mass of pollutants are in the unsaturated zone of the soil, this site is considered a good candidate for the application of vapor extraction. If a significant mass of pollutants is in the saturated zone, dewatering may be used to remove the ground water and enhance the transport of pollutants from the soil matrix. The practicality of dewatering a site is dependent on the depth, soil material, dewatering area, ground water recharge, and discharge requirements for the ground water. Hydrogeologic and ground water quality data must be available to evaluate the ability to dewater a site. If greater than 10% of the total mass of pollutants on-site is in the saturated zone and dewatering is feasible, a site is considered to be a fair candidate for vapor extraction. If greater than 10% of the total mass of pollutants is below the saturated zone and the site is difficult to dewater, then the site is considered to be a poor candidate for vapor extraction.

#### Initial Screening Score

The overall evaluation of a site uses the weights and parametric scores as shown in Table 1. The primary parameter is the volatility of the contaminants which is given a weighting factor of 3. The transport characteristics of the contaminants in the soil are of secondary importance and are weighted with a factor of 2. Finally, the potential for ground water interference is weighted with a factor of 1. The values of the parameters are

scored as good (80 points), fair (60 points), or poor (30 points) as shown in Table 1.

An overall score is then calculated according to Equation 1 on Table 1. This score is used to evaluate the feasibility of using vapor extraction technology on a particular site. A score of 60 or more generally indicates that use of the technology is feasible and that a pilot test should be conducted. A score less than 60 but greater than or equal to 50 is marginal and indicates a need to reevaluate alternate technologies. A score of less than 50 indicates that vapor extraction technology is not appropriate for the site and should not be selected for use as a remediation technology.

#### **PERFORMANCE ANALYSIS**

It is necessary to perform a pilot test to determine how the process will perform for a particular application. The pilot test is used to determine the zone of influence of the vapor extraction well, the initial pollutant mass extraction rate, and the necessity for emission controls. These parameters, in addition to the site stratigraphy and contaminant distribution, are critical to determining the cost of a vapor extraction system.

##### **Zone of Influence**

The radial zone of influence of a well will determine the number of extraction wells required. The zone of influence is a function of the air extraction rate and the extraction well negative pressure. As the zone of influence increases, the number of extraction wells required decrease.

### **Initial Extraction Rate**

The initial extraction rate will determine the length of time an extraction system must be operated. The contaminant mass extraction rate may be determined by multiplying the air extraction rate by the extracted air contaminant concentration. Since the contaminant distribution is known from the site investigation, the extraction rate may be expressed as a percent of the total contaminant mass. The initial extraction rates can be used to estimate the total operating time for site remediation.

### **Emission Controls**

Emission controls may be used to reduce the concentration of the extracted air contaminants. Emission controls may be applied during the early stages of a vapor extraction remediation project, when the mass extraction rate is likely to be high. Emission controls will increase the cost of a system.

### **Pilot Test Screening Score**

These three factors are as shown in Table 2. A performance analysis score is then calculated using Equation 1 (Table 1). If the score is less than 50 points, the vapor extraction technology is rejected as impractical. If the score be greater than or equal to 50 but less than 60, the alternative technologies should be reevaluated. If the score is greater than 60 the process is recommended for the site.

### **Verification of Clean Up**

Final soil contaminant concentrations may be calculated using mass balance techniques based on the difference between the initial contaminant mass on site and the field determined mass

extraction rate. Soil samples may be collected to confirm calculated results. Alternatively, laboratory soil aeration studies may be conducted on field collected samples to determine an effective Henry's Law factor. This factor would incorporate soil adsorption effects and other interferences expected under field conditions. This factor, the gas flow rate and soil characteristics may be used to estimate the aeration time required to meet final contaminant concentration clean up standards (6). However, laboratory studies may require from 4 weeks to 6 months (5) and will not eliminate the need for pilot testing.

## REFERENCES

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- (2) M. Bennedsen, J. Scott, J. Hartley, Use of Vapor Extraction Systems for In Situ Removal of Volatile Organic Compounds from Soil: Proceedings of the National Conference on Hazardous Wastes and Hazardous Materials, March 16-18, 1987.
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- (4) M. Marley, G. Hoag, Induced Soil Venting for the Recovery/Restoration of Gasoline Hydrocarbons in the Vadose Zone: Proceedings of Petroleum Hydrocarbons and Organic Chemicals in Ground Water, Prevention and Restoration - A Conference and Exposition, Nov. 5-7, 1984.
- (5) A. Clark, D. Wilson, A Phased Approach to the Development of In Situ Vapor Stripping Treatment: Proceedings of the First Annual Hazardous Materials Management Conference/Central, March 15-17, 1988.
- (6) D. Wilson, Mathematical Modeling of In Situ Vapor Stripping of Contaminated Soils: Proceedings of the First Annual Hazardous Materials Management Conference/Central, March 15-17, 1988.
- (7) W. Lyman, W. Reehl, D. Rosenblatt, Handbook of Chemical Property Estimation Methods - Environmental Behavior of Organic Compounds, McGraw-Hill, 1982.
- (8) Permeability Chart, E.C. Jordon Co., 562 Congress Street, Portland, ME 04112

TABLE 1  
VAPOR EXTRACTION FEASIBILITY ANALYSIS TABLE

Rating	Parameter		
	Contaminant Henry's Law Constant (atm-m <sup>3</sup> /mol) (wf=3)	Soil Permeability (cm <sup>3</sup> /cm <sup>2</sup> /sec) (wf=2)	Ground Water Interference (wf=1)
Good (Score 80)	$K_h > 10^{-4}$	Sands $K > 10^{-3}$	90% of total contaminant mass in unsaturated zone
Fair (Score 60)	$10^{-7} < K_h < 10^{-4}$	Mixed soils $10^{-6} < K < 10^{-3}$	>10% in saturated zone, feasible dewatering
Poor (Score 30)	$K_h < 10^{-7}$	Clays $K < 10^{-6}$	>10% in saturated zone, difficult dewatering

wf = Weighting Factor

Equation 1.  $Score = S_T = \sum S_i W_j / \sum W_j$

where:  $S_T$  = total score  
 $S_i$  = score for parameter i  
 $W_j$  = weighting factor for parameter

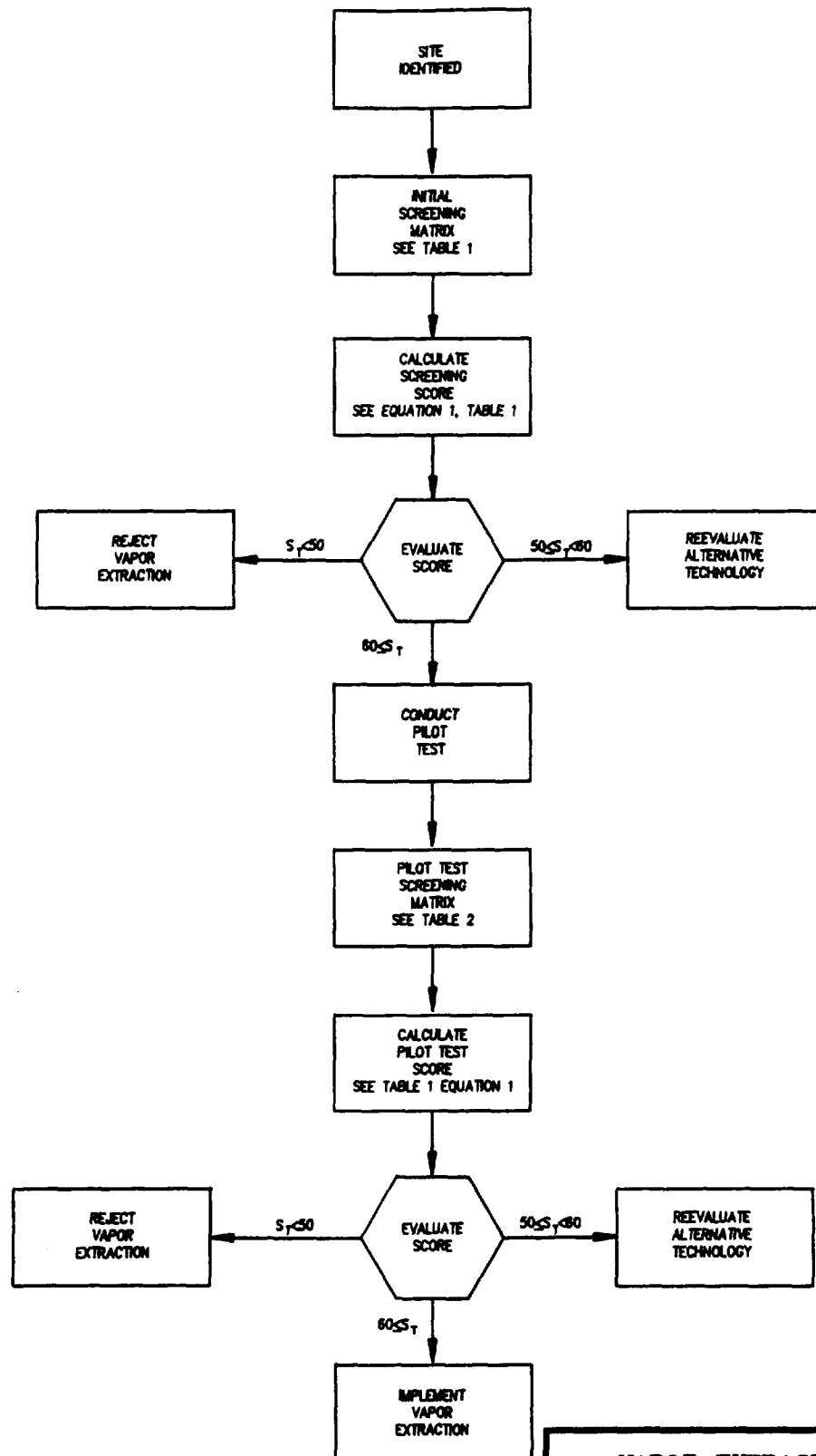
TABLE 2

## VAPOR EXTRACTION PERFORMANCE ANALYSIS TABLE

Rating	Parameter			
	Zone of Influence (wf=3)		Initial Contaminant Mass Extraction Rate (wf=2)	Emission Controls Required (wf=1)
	<u>Sands</u>	<u>Clays</u>		
Good (Score 80)	>50 ft.	>20 ft.	>5% total mass on site/day	None
Fair (Score 60)	20<ZOI<50	10<ZOI<20	1%/day<ER<5%/day	During Initial Remediation
Poor (Score 30)	<25 ft.	<10 ft.	<1%/day	Continuously During Remediation

wf = Weighting Factor  
 ZOI = Zone of Influence  
 ER = Extraction Rate





# VAPOR EXTRACTION EVALUATION

**ERM** ERM-North Central, Inc.

FIGURE

1

**ATTACHMENT 2**

**TERRA VAC PILOT TEST**  
**AT**  
**ENVIRONMENTAL CHEMICAL AND CONSERVATION CORP.**  
**ZIONSVILLE, INDIANA**

**INTRODUCTION**

This report discusses the results of the vacuum extraction pilot test conducted by Terra Vac with ERM-North Central at the Environmental Chemical and Conservation Corporation (ECC) NPL site in zionsville, indiana. The report discusses the major project activities, data gathered, and significant findings in the following sections:

- I. Summary
- II. System Installation
- III. Vacuum Extraction Operations
- IV. Analytical QA/QC
- V. Projection of Clean-Up Time

**I. SUMMARY**

The vacuum extraction pilot test was successful in demonstrating the Terra Vac Process as a technically sound and cost effective method for removing volatile organics from the ECC site soils. Horizontal extraction wells were shown to be superior to vertical extraction wells for the site geology. Clean up time for the site using vacuum extraction was estimated to be 350 days.

During Terra Vac's pilot test and operating period, approximately 548 pounds of VOCs were removed from the site. Tests show an approximate 20 foot radius of influence for horizontal extraction

wells. Because of the high extraction rates from Horizontal Extraction Well HEW-2, the majority of extraction operations were directed there. The extended run time on HEW-2 developed the data necessary to project clean up time. The vacuum extraction operations began on June 13 and continued, with only minor shut downs, until July 20.

## II. SYSTEM INSTALLATION

During the week of June 1, Terra Vac's personnel arrived on site to receive and procure materials for the job. Trenching began on June 7 continued until June 8. Subsurface vacuum monitoring wells at Vertical Extraction Well (VEW-1) were installed during the remainder of the week. Following extraction trench installation, the major components of the extraction system were manifolded together. Figure 1 is a drawing showing the layout of the test site.

During trench installation soil samples were taken and analyzed for VOCs using the headspace method. As expected, the VOC concentration was highly variable over the length of the trench. Table 1 is a summary of the chemical analyses of the soil samples.

## III. VACUUM EXTRACTION OPERATIONS

Appendix A is a daily summary of the system's and each well's operations. Appendix B contains operating and analytical data taken during the pilot test.

### A. Well Development

HEW-2 was initially developed for 22 hours. The results of the development period showed high VOC extraction rates and a radius of influence expanding to approximately 15 feet. Following development of HEW-2, vacuum extraction from HEW-1 and VEW-1 was initiated as a combined development. The combined development continued for approximately four more days. The results of that development period indicated that HEW-1 had lower VOC extraction rates than HEW-2 but a comparable radius of influence. However, no significant radius of influence was measured from the vertical extraction well (VEW-1).

### B. Operations

Figure 2 is a plot of the Cumulative Pounds of VOC Extracted by the System versus Run Time. Approximately 548 pounds of VOC were removed from the site during Terra Vac's operations. After well development, operations focussed on HEW-2, where VOC concentrations were expected and found to be highest. HEW-2 remained in operation for a total of 31.4 days, with a total of 470.8 pounds of VOCs removed, as shown in Figure 3. The radius of influence stabilized at 15 to 20 feet.

Figure 4 and 5 show cumulative VOCs removed from HEW-1 and VEW-1. The short run times reflect both the slow development of VEW-1 and the decision to operate HEW-2 solely. Following development, the unexpectedly high flow rates from HEW-2 necessitated its solo operation so that the pilot system's effectiveness could be maximized.

Figure 6 shows HEW-2 VOC removal rates vs. run time. This type of curve is consistent with Terra Vac's previous experience. Early high rates decline to a relatively stable removal rate that slowly decreases (spikes before day 10 were caused by

optimization procedures or short term shutdowns). Figure 7, showing initial and final rates for the major contaminants at HEW-2, indicates how these changes in VOC removal rate occur. There are substantial drops in rates from beginning to end for the more volatile components such as DCE, TCA, and TCE, while rates for Toluene, PCE, and Xylenes have changed little or increased. The Total VOC Removal Rate dropped by 87% from its high point of 76 lb/day to a low point of 9.9 lb/day when the system was shut off.

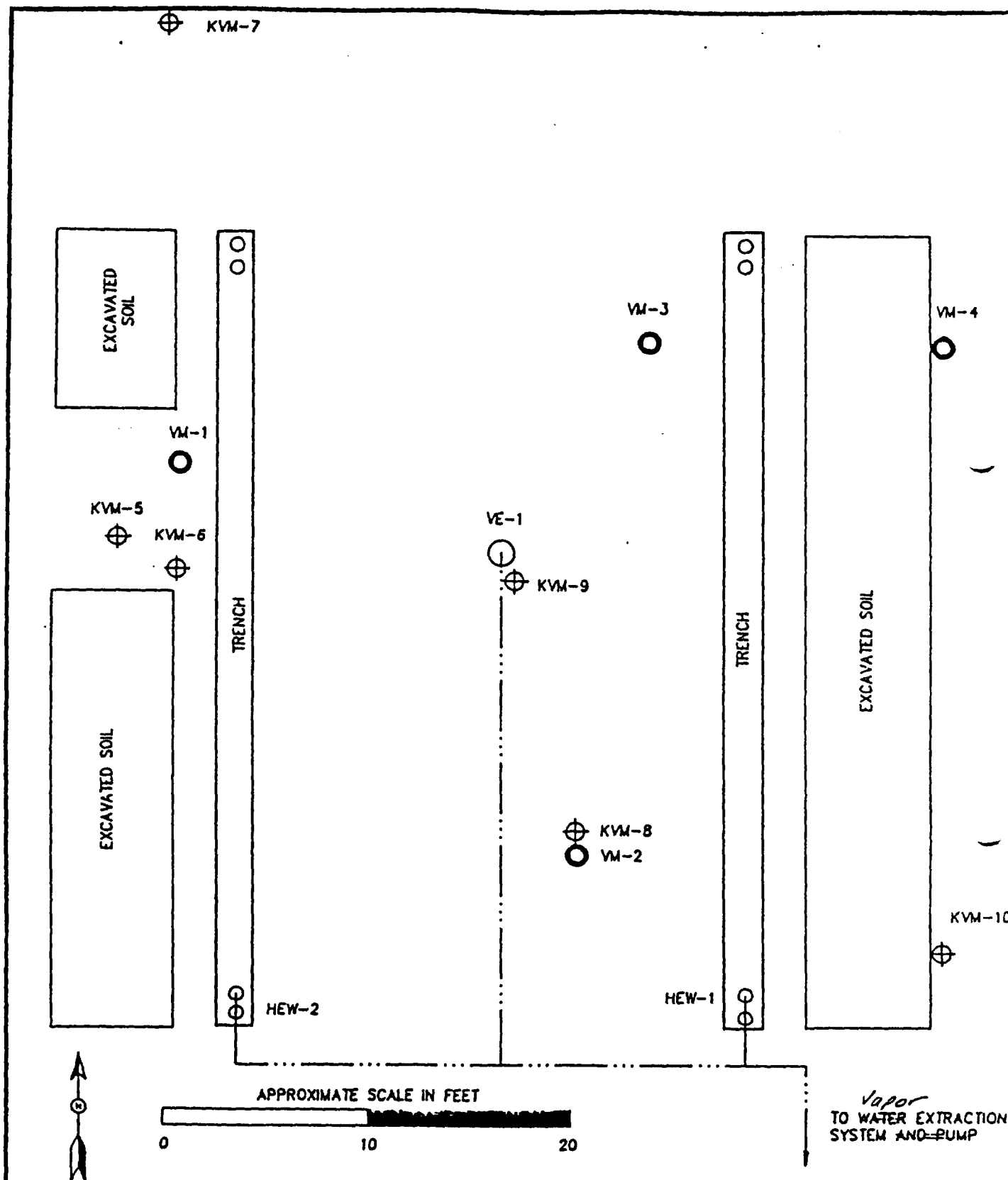
The extracted VOCs were treated using a dispersion stack under a variance from the Indiana Department of Environmental Protection. Air quality testing was performed at the site boundary by ERM-North Central using a hand held vapor analyzer with a photoionization detector. At no time did concentrations of the indicator compounds at the site boundary exceed allowable limits.

#### IV. ANALYTICAL QA/QC

Several attachments (1-4) are included in this report that outline GC parameters, sampling and QC procedures. Vapor analyses were by direct injection of samples into a Shimadzu GC-9A gas chromatograph equipped with a flame ionization detector and utilizing a capillary column for separation of the compounds. Calibration checks or recalibrations were done daily, prior to sampling. All sample syringes were air purged via pump, with several blanks run to verify efficiency of purging procedure. Questionable results (i.e., an unusual change in concentration) was cause to run a syringe blank and resample to verify initial analysis.

## **V. PROJECTION OF CLEAN-UP TIME**

Based upon data collected from the operation of HEW-2, the clean-up time for the site using vacuum extraction technology is projected to be 300 to 400 days.



ECC SITE  
SOIL VAPOR EXTRACTION SYSTEM  
PILOT TEST LAYOUT

ERM North Central, Inc.

FIGURE

1-1



TABLE ONE

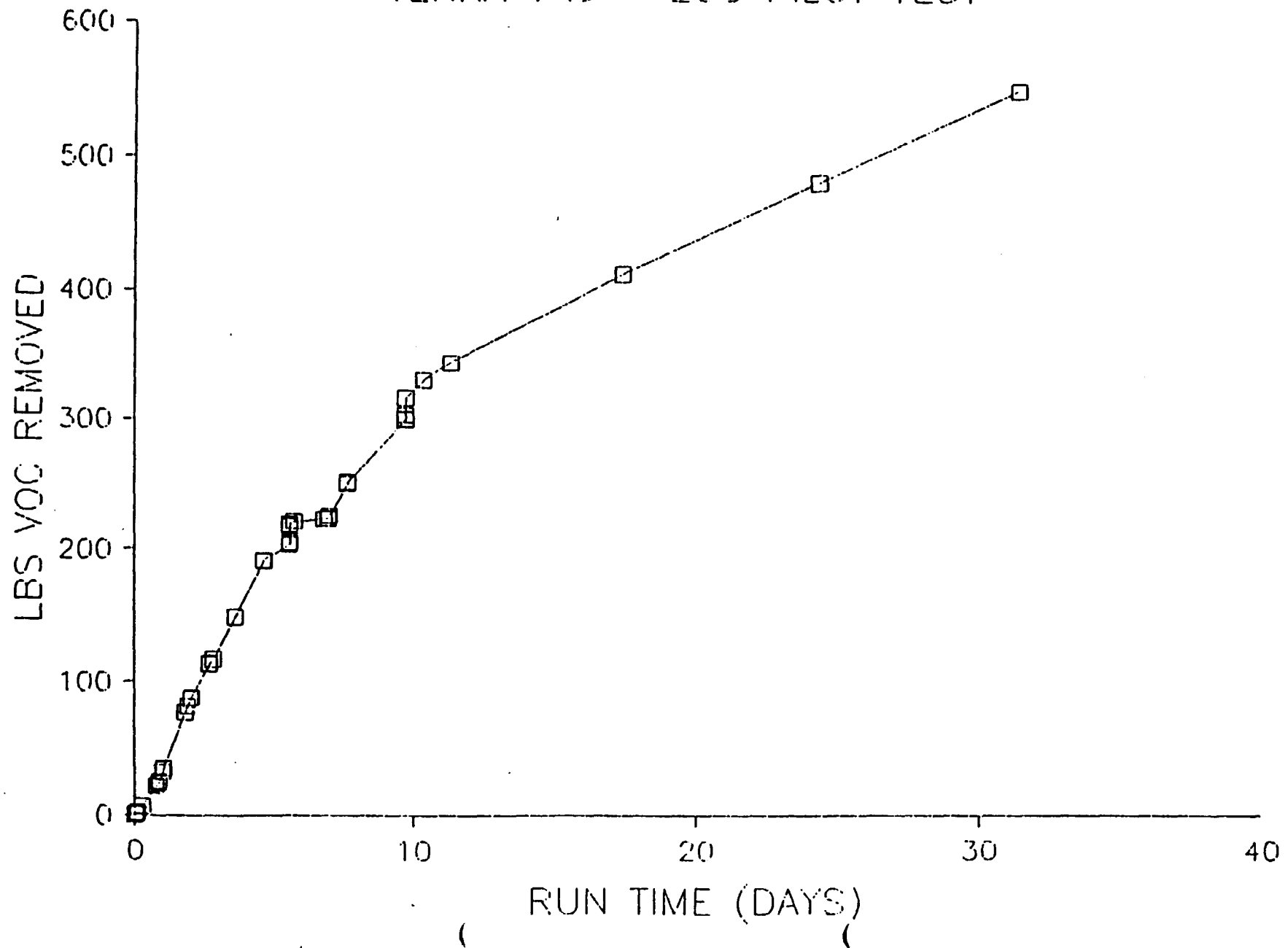
ECC SOILS DATA  
TERRA VAC PILOT TEST

HEW-1 SOIL SAMPLE ID	HEW-1 DEPTH FT.	HEW-1 DCE ppm	HEW-1 TCA ppm	HEW-1 BZ ppm	HEW-1 TCE ppm	HEW-1 TOL ppm	HEW-1 PCE ppm	HEW-1 mp-XYL ppm	HEW-1 TOTAL ppm
===== SOIL CONCENTRATION (PPH) =====									
T1-3-3	3.0	.2	3.2	NA	7.7	1.9	4.5	1.9	19.4
T1-6-7	7.0	.4	2.4	NA	4.5	2.1	9.6	2.2	9.4
T1-6-9	9.0	.1	.0	NA	.0	.0	.1	.0	.2
T1-12-4	4.0	2.4	59.6	NA	99.7	5.1	187.5	2.3	166.7
T1-12-7	7.0	4.5	63.9	NA	125.0	5.9	155.2	2.2	199.3
T1-20-2	2.0	6.8	18.3	NA	59.0	10.6	2.4	2.9	94.5
T1-25-7	7.0	3.9	8.8	NA	24.5	4.0	11.5	1.7	41.1
T1-35-5	5.0	7.7	45.6	NA	7.9	4.6	4.0	1.8	65.7
T1-35-6	6.0	62.3	96.2	NA	49.7	9.4	103.1	3.8	217.6
T1-40-3	3.0	6.3	4.3	NA	2.0	.5	1.6	.2	13.1
T1-40-5	5.0	1.5	22.4	NA	2.6	1.0	1.1	.5	27.5
T1-40-7	7.0	.7	67.4	NA	9.0	6.9	1.9	.6	84.1

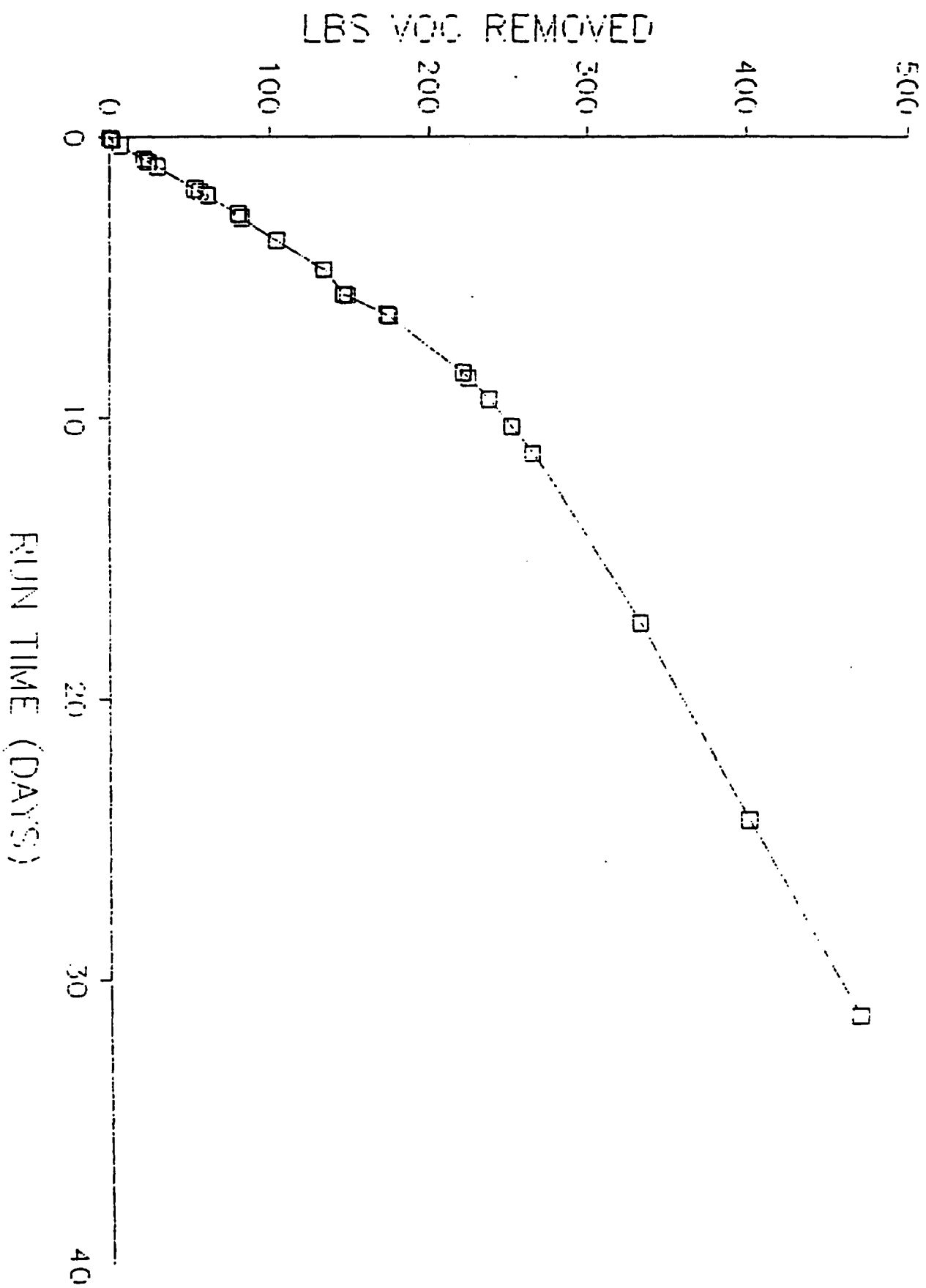
HEW-2 SOIL SAMPLE ID	HEW-2 DEPTH FT.	HEW-2 DCE ppm	HEW-2 TCA ppm	HEW-2 BZ ppm	HEW-2 TCE ppm	HEW-2 TOL ppm	HEW-2 PCE ppm	HEW-2 mp-XYL ppm	HEW-2 TOTAL ppm
===== SOIL CONCENTRATION (PPH) =====									
T2-5-3	3.0	.6	3.6	NA	6.5	3.3	1.5	2.3	14.0
T2-5-7	7.0	1.1	180.8	NA	10.6	19.7	4.9	8.8	212.1
T2-5-9	9.0	.2	5.1	NA	8.5	1.2	8.7	1.0	15.0
T2-15-2	2.0	1.5	109.6	NA	6.8	15.3	2.1	3.4	133.2
T2-15-8	8.0	1.1	83.0	NA	16.2	13.8	2.2	4.9	114.1
T2-18-5	5.0	1.1	40.2	NA	12.0	.8	1.9	.1	54.2
T2-22-3	3.0	.4	54.7	NA	20.1	4.0	4.7	1.8	79.1
T2-22-8	8.0	.1	1.8	NA	.7	.4	.2	.2	3.0
T2-35-3	3.0	1.6	37.9	NA	58.7	18.1	26.4	10.1	116.2
T2-35-4	4.0	.6	54.5	NA	333.9	25.5	35.0	6.4	414.4
T2-35-7	7.0	1.4	68.9	NA	71.3	19.2	20.6	13.7	160.7
T2-43-5	5.0	2.5	153.5	NA	24.8	13.3	5.6	5.8	194.1
T2-45-2	2.0	.9	68.9	NA	21.7	12.5	3.8	4.1	103.9
T2-45-6	6.0	1.6	116.8	NA	15.4	14.1	2.5	4.6	147.8

# TOTAL LBS VOC REMOVED

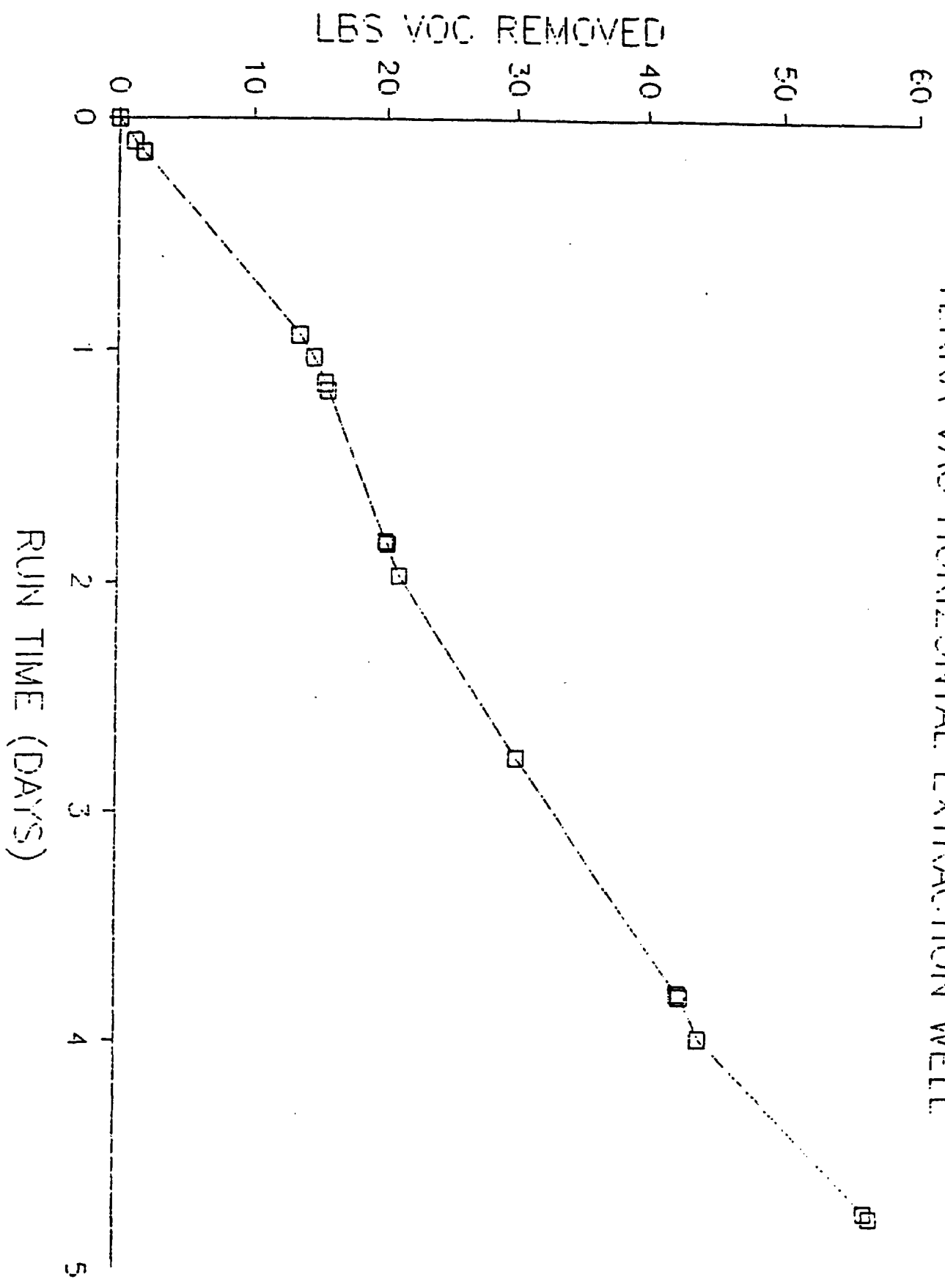
## TERRA VAC - ECC PILOT TEST



# HEW-2 LBS VOC REMOVED TERRA VAC HORIZONTAL EXTRACTION WELL

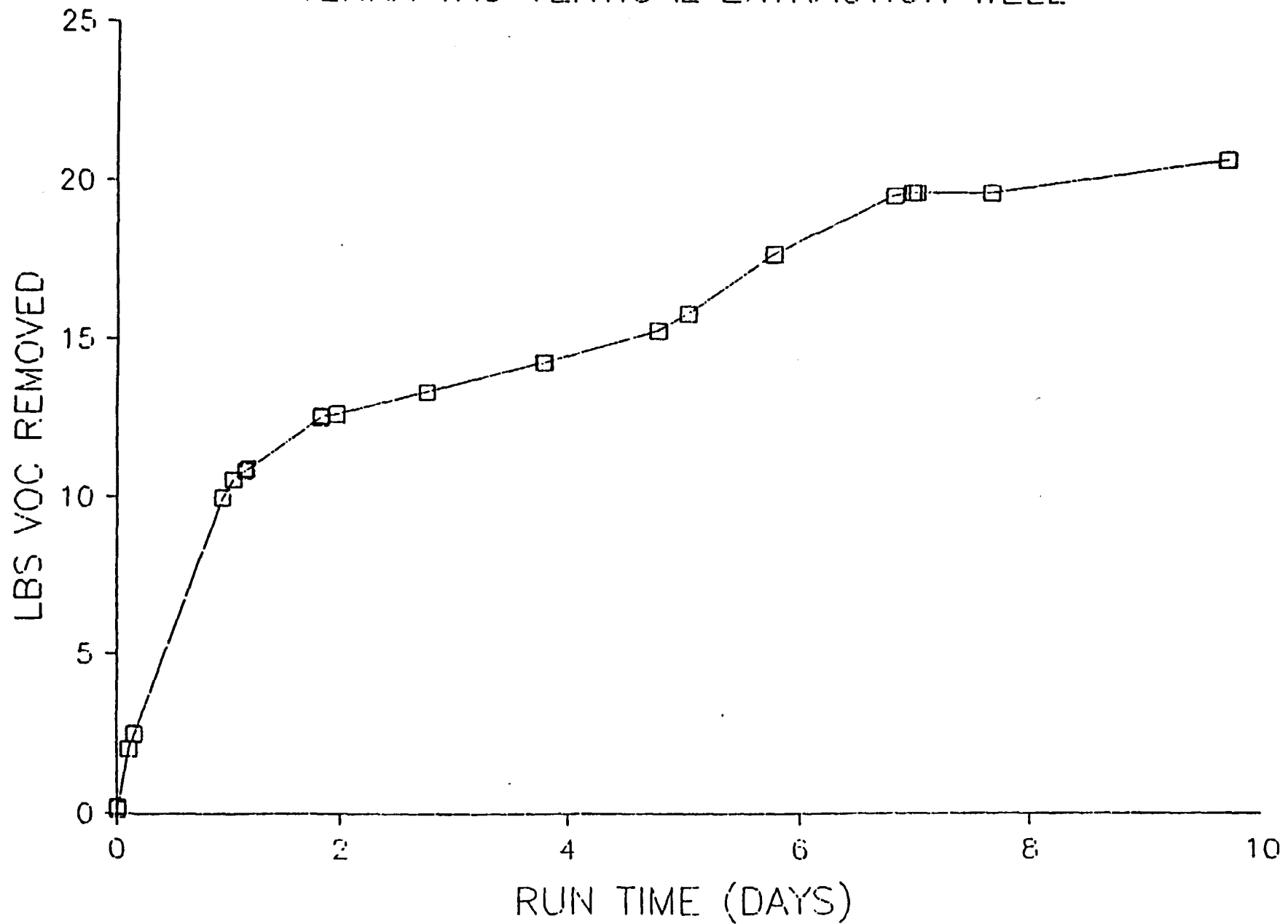


HEW-1 LBS VOC REMOVED  
TERRA VAC HORIZONTAL EXTRACTION WELL

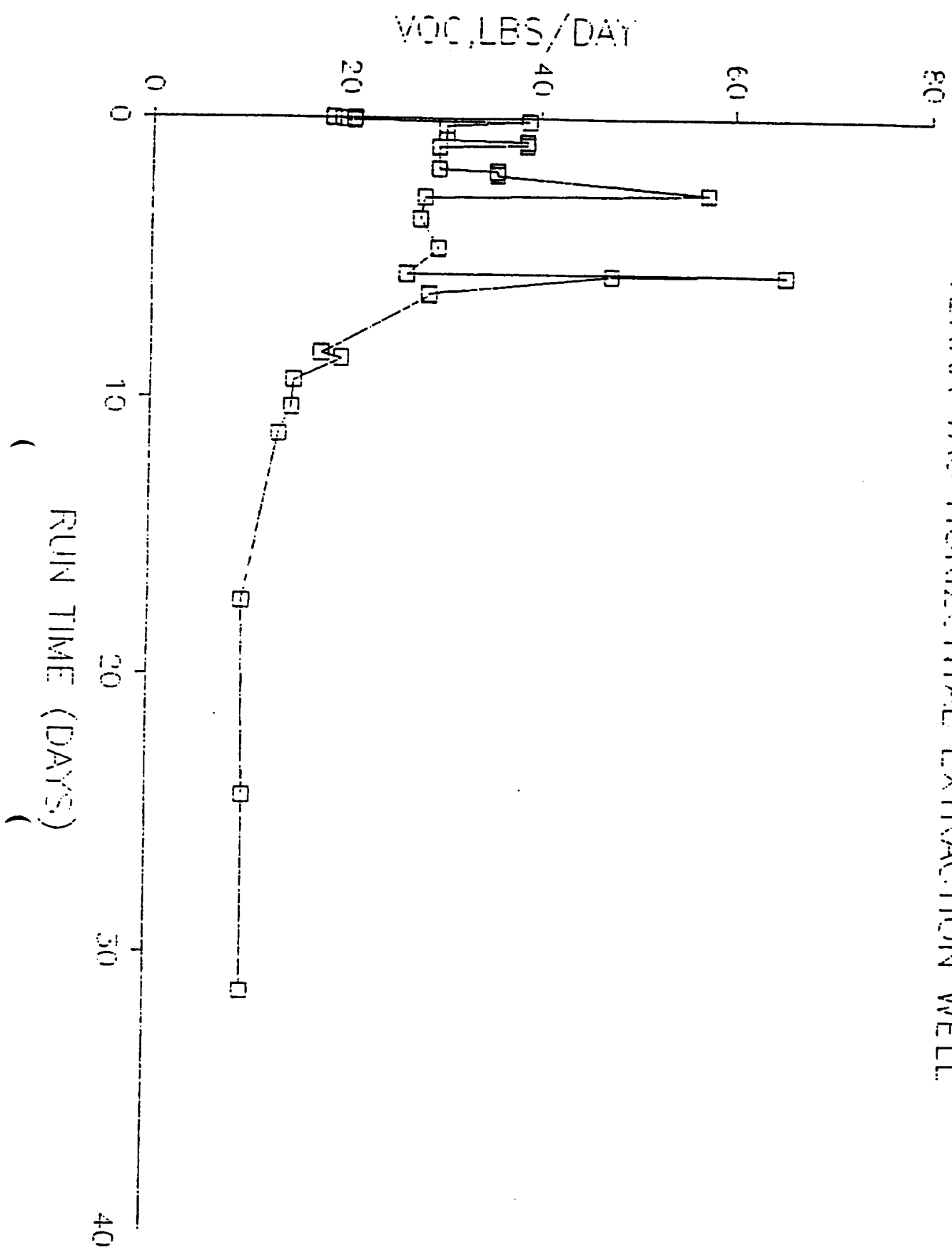


( RUN TIME (DAYS) )

VIEW-1 LBS VOC REMOVED  
TERRA VAC VERTICAL EXTRACTION WELL



# HEW-2 VOC REMOVAL RATES, TERRA VAC HORIZONTAL EXTRACTION WELL



TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

XX SUMMARY - ECC VACUUM EXTRACTION PILOT TEST													
XX													
SAMPLE TIME		XX	X										
		XX	RUN X	FLOW	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUM
		XX	TIME X	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS MIN	XX	(DAYS)X	(SCFH)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17	XX	.00 X	0	0	0	0						0
14-Jun 12	18	XX	.00 X	4	.9	6.4	6.3	.5	1.1	.1	2.9	18.2	
14-Jun 12	38	XX	.01 X	4	.8	10.4	4.7	.7	.7	.1	3.0	20.5	
14-Jun 13	18	XX	.04 X	4	.9	10.3	4.3	.7	.9	.2	1.9	19.2	1
14-Jun 13	31	XX	.05 X	4									1
14-Jun 14	31	XX	.05 X	4									1
14-Jun 15	31	XX	.09 X	4	.7	11.5	4.7	.9	.9	.2	1.5	20.4	1
14-Jun 15	40	XX	.10 X	4									2
14-Jun 16	29	XX	.10 X	4									2
14-Jun 17	29	XX	.14 X	8	1.1	20.7	9.7	1.9	2.1	.6	2.7	38.7	2
14-Jun 20	42	XX	.28 X	8	.8	14.2	8.8	1.6	1.9	.5	2.1	30.1	7
15-Jun 8	39	XX	.77 X	17									22
15-Jun 9	20	XX	.77 X	17									22
15-Jun 11	30	XX	.86 X	17	1.0	15.5	13.4	2.2	3.0	.8	2.6	38.5	24
15-Jun 12	10	XX	.89 X	16								38.5	25
15-Jun 12	23	XX	.90 X	21	3.2	8.0	13.8	.3	1.4		.7	66.1	25
15-Jun 12	27	XX	.90 X	23	.8	2.9	1.5	.1	2.1		1.5	75.1	25
15-Jun 14	50	XX	1.00 X	38	1.3	9.4	5.3	1.0	4.1	.4	2.7	62.8	32
15-Jun 15	55	XX	1.05 X	41	.8	11.3	10.6	1.7	2.4	.5	2.1	53.6	35
15-Jun 16	2	XX	1.05 X	59								53.6	35
16-Jun 10	48	XX	1.83 X	79								53.6	77
16-Jun 13	6	XX	1.93 X	84	1.6	16.6	15.3	2.5	5.3	.8	3.4	45.5	82
16-Jun 15	45	XX	2.04 X	86								45.5	87
16-Jun 16	30	XX	2.07 X	98								45.5	88
16-Jun 19	15	XX	2.07 X	121									88
17-Jun 10	45	XX	2.72 X	191	2.9	23.5	24.4	3.2	8.6	1.0	12.3	75.9	113
17-Jun 11	0	XX	2.73 X	0	1.1	6.3	3.6	.5	3.4	1.0	12.3	75.9	114
17-Jun 11	40	XX	2.73 X	0									114
17-Jun 15	0	XX	2.87 X	202	.7	14.2	14.2	2.1	6.7	.6	3.4	41.9	116





TERRA VAC/ ECC - ERH SITE / PROJECT 88-304

XX														
XX HORIZONTAL EXTRACTION WELL - HEW-1												HEW-1		
XX														
SAMPLE TIME		XX	<<< OPERATING SUMMARY >>>											
		XX	RUN	FLOW	TOTAL	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUH
		XX	TIME	RATE	VOC	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS	MIN	XX	(DYS)	(SCFM)	(mg/l)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
<hr/>														
14-Jun	12	17	XX											
14-Jun	12	18	XX											
14-Jun	12	38	XX											
14-Jun	13	18	XX											
14-Jun	13	31	XX											
14-Jun	14	31	XX											
14-Jun	15	31	XX											
14-Jun	15	40	XX											
14-Jun	16	29	XX											
14-Jun	17	29	XX											
14-Jun	20	42	XX											
15-Jun	8	39	XX											
15-Jun	9	20	XX											
15-Jun	11	30	XX											
15-Jun	12	10	XX											
15-Jun	12	23	XX										.00	
15-Jun	12	27	XX		2	58.74	.8	2.9	1.5	.1	2.1	1.47	8.9	
15-Jun	14	50	XX	.1	17	9.97	.9	5.2	2.3	.7	3.7	.3	1.70	14.8
15-Jun	15	55	XX	.1	17									1.2
15-Jun	16	2	XX	.2	25									1.9
15-Jun	16	2	XX	.2	25									1.9
16-Jun	10	48	XX	.9	33									13.5
16-Jun	13	6	XX	1.0	34	2.50	.5	2.8	1.2	.3	2.1	.1	.62	14.5
16-Jun	15	45	XX	1.1	34									15.4
16-Jun	16	30	XX	1.2	39									15.6
16-Jun	19	15	XX	1.2	52									15.6
17-Jun	10	45	XX	1.8	68	2.23	.8	4.6	1.9	.3	3.0	.1	3.00	20.0
17-Jun	11	0	XX	1.8		2.23	.8	4.6	1.9	.3	3.0	.1	3.00	20.1
17-Jun	11	40	XX	1.8										20.1
17-Jun	15	0	XX	2.0	82	1.78	.7	4.9	2.0	.4	3.6	.2	1.44	21.0

AL

[illegible]

TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

		XX	XX VERTICAL EXTRACTION WELL - VE-1											VE-1
		XX												
SAMPLE TIME		XX	<<< OPERATING SUMMARY >>>											
		XX	RUN	FLOW	TOTAL	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUM
		XX	TIME	RATE	VOC	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS MIN	XX		(SCFH)	(mg/L)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17	XX												
14-Jun 12	18	XX												
14-Jun 12	38	XX												
14-Jun 13	18	XX												
14-Jun 13	31	XX												
14-Jun 14	31	XX												
14-Jun 15	31	XX												
14-Jun 15	40	XX												
14-Jun 16	29	XX												
14-Jun 17	29	XX												
14-Jun 20	42	XX												
15-Jun 8	39	XX												.00
15-Jun 9	20	XX												
15-Jun 11	30	XX												
15-Jun 12	10	XX												
15-Jun 12	23	XX		4	73.67	3.2	8.0	13.8	.3	1.4		.7	27.6	.1
15-Jun 12	27	XX		4									27.6	.2
15-Jun 14	50	XX	.1	4	25.36	.4	4.2	3.0	.4	.4	.1	1.0	9.5	2.0
15-Jun 15	55	XX	.2	8									9.5	2.5
15-Jun 16	2	XX	.2	8									9.5	2.5
16-Jun 10	48	XX	.9	13									9.5	10.0
16-Jun 13	6	XX	1.0	13	2.18	.1	1.0	.5	.3	.1		.5	2.5	10.5
16-Jun 15	45	XX	1.1	15									2.5	10.8
16-Jun 16	30	XX	1.2	15									2.5	10.9
16-Jun 19	15	XX	1.2	15										10.9
17-Jun 10	45	XX	1.8	17	3.31	.3	1.7	1.7	.3	.3	.1	.5	5.0	12.5
17-Jun 11	0	XX	1.8		3.31	.3	1.7	1.7	.3	.3	.1	.5	5.0	12.5
17-Jun 11	40	XX	1.8											12.5
17-Jun 15	0	XX	2.0	4	2.53	.1	.4	.2	.1		.1	.9	12.6	



TERRA TRC/ ECC - ERM SITE / PROJECT 88-304

		HORIZONTAL EXTRACTION WELL - REV-1														REV-1		REV-1	
		(( OPERATION DATA ))				(( GAS CHROMATOGRAPH READOUT ))								(( WELLHEAD CONCENTRATION ))					
		INJ	WELL FLOW	FLOW	1.1	1.1.1	M.F- TOTAL				1.1	1.1.1	M.F-						
		SAMP VOL	VAC RATE	RATE	DCE	YCA	YCE	YOL	PCE	ITL	AREA	DCE	YCA	YCE	YOL	PCE	ITL	OTHER	
DATE	HRS MIN	XX	NUM	(ml)	(°sq)	(SCFH)	(ACFH)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	1000X	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
14-Jun 12	17	XX																	
14-Jun 12	18	XX	100	1.0															
14-Jun 12	38	XX	100	1.0															
14-Jun 13	18	XX	100	1.0															
14-Jun 13	31	XX	100	1.0															
14-Jun 14	31	XX	100	1.0															
14-Jun 15	31	XX	100	1.0															
14-Jun 15	40	XX	100	1.0															
14-Jun 16	29	XX	100	1.0															
14-Jun 17	29	XX	100	1.0															
14-Jun 20	42	XX	100	1.0															
15-Jun 8	39	XX	100	1.0															
15-Jun 9	20	XX	100	1.0															
15-Jun 11	30	XX	100	1.0															
15-Jun 12	10	XX	100	1.0															
15-Jun 12	23	XX	777	100	1.0														
15-Jun 12	27	XX	114	100	8.5	2	2	.377	1.360	.701	.034	1.015	.008	1210	5.26	19.26	9.76	.47	14.16
15-Jun 14	50	XX	115	100	9.5	17	20	.040	.241	.107	.030	.170	.015	154	.59	3.53	1.57	.44	2.49
15-Jun 15	55	XX	686	100	9.5	17	20												
15-Jun 16	2	XX	888	100	9.5	25	30												
16-Jun 10	48	XX	688	100	9.5	33	40												
16-Jun 13	6	XX	122	100	8.8	34	40	.012	.065	.027	.006	.049	.003	44	.17	.92	.38	.08	.69
16-Jun 15	45	XX	688	100	8.8	34	40												
16-Jun 16	30	XX	999	100	1.0	39	46												
16-Jun 19	15	XX	777	100	1.0	52	53												
17-Jun 10	45	XX	174	100	8.4	66	80	.009	.054	.022	.003	.036	.001	54	.13	.75	.31	.04	.50
17-Jun 11	0	XX	999	100	1.0														
17-Jun 11	40	XX	777	100	1.0														
17-Jun 15	0	XX	127	500	9.7	82	100	.031	.227	.050	.018	.163	.007	158	.09	.67	.27	.05	.48

TELEA TAC/ ECC - LBN SITE / PROJECT 88-304

[illegible]

**TECHNICAL DIFFICULTIES FILE - FE-1**

SAMPLE TIME	TIME	(( OPERATOR DATA ))				(( GAS CHROMATOGRAPH READOUT ))				(( THERMAD CONCENTRATION ))			
IN	OUT	IN	OUT	PER	TIME	IN	OUT	PER	TIME	IN	OUT	PER	TIME
14-JUN 12 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 12 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 12 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 13 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 02	02	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 03	03	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 04	04	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 05	05	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 06	06	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 07	07	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 08	08	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 09	09	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 14 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 02	02	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 03	03	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 04	04	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 05	05	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 06	06	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 07	07	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 08	08	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 09	09	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 15 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 02	02	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 03	03	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 04	04	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 05	05	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 06	06	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 07	07	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 08	08	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 09	09	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 16 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 02	02	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 03	03	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 04	04	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 05	05	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 06	06	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 07	07	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 08	08	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 09	09	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 17 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 02	02	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 03	03	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 04	04	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 05	05	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 06	06	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 07	07	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 08	08	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 09	09	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 10	10	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 11	11	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 12	12	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 13	13	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 14	14	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 15	15	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 16	16	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 17	17	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 18	18	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 18 19	19	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 19 00	00	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 19 01	01	100	1.0	1.1	1.1	0	0	0	0	0	0	0	0
14-JUN 19 02	02	100	1.0										

TEHRA TAC/ ECC - ERM SITE / PROJECT 88 - 304

II VERTICAL EXTRACTION WELL - VE-1																	VERTICAL EXTRACTION WELL - VE-1														
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## TERRA VAC CORPORATION

Project 88-304

Gas Chromatograph ParametersI. SCOPE

In order to accurately quantitate Volatile Organic Compound (VOC) content it is necessary to insure peak separation. This is achieved by the use of an appropriate column, with the aid of a temperature program. The parameters for this program are set forth here.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Temperature programmable gas chromatograph (Shimadzu GC-9A) equipped with a flame ionization detector (FID) and a wide bore capillary column.
3. Nitrogen, carrier gas, zero grade or better
4. Hydrogen, combustion gas, zero grade or better
5. Air, combustion gas, zero grade or better

III. PARAMETERS

1. Initial temperature, 40 C
2. Initial hold, 2 minutes
3. Program rate, 5 C/minute
4. Intermediate temperature, 85 C
5. Intermediate hold, 0.5 minutes
6. Secondary ramp rate, 15 C/minute
7. Final temperature, 150 C
8. Final hold, 3 minutes
9. Inlet temperature, 150 C
10. Carrier gas flow, 20 ml/minute
11. Combustion gas flow, Air, 350 ml/minute
12. Combustion gas flow, Hydrogen, 55 ml/minute
13. Detector range, 10<sup>-1</sup>

IV. PRECAUTIONS

Do not exceed temperature limit of column. Do not operate oven without oven fan operating. Periodically check and clean air filter to electronics. Technician must be fully trained before attempting to operate the gas chromatograph.

TERRA VAC CORPORATION

Project 88-304

Integrator Parameters

I. SCOPE

The parameters stated here are normal operating parameters for use with a flame ionization detector (FID). These parameters will require periodic optimization by the operator in order to achieve maximum sensitivity.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Integrator (Shimadzu C-R3A)

III. PARAMETERS

1. Zero = 0
2. Attenuation (ATTN 2 ) = 4
3. Chart speed (CHT SP) = 10 mm/min.
4. Area reject (AR REJ) = 250
5. Slope = 300

IV. PRECAUTIONS

It is important that the operator has a full understanding of the instrument in order to achieve optimization. If in doubt about any procedure, refer to the operation manual.

TERRA VAC CORPORATION

Project 88-304

Sampling Techniques of Volatile Organic Compounds

I. SCOPE

Volatile Organic Compounds (VOC) are regulated, toxic chemicals and should be treated with care to avoid personal and environmental contamination.

When sampling vapors from the vacuum system it will be considered that the air stream is contaminated with VOC's.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Hamilton Gastight Syringes 1000ul, 500ul, 250ul sizes

III. PROCEDURE

1. Purge syringe with clean air
2. Insert syringe into well head septum
3. Purge syringe with air stream to be sampled
4. Draw plunger back to desired volume
5. Withdraw needle from wellhead septum and stopper with a septum
6. Log time, location, wellhead vacuum and flow then return sample to GC

IV. PRECAUTIONS

Test syringe before use for leaking plunger and tight needle.

## TERRA VAC CORPORATION

Project 88-304

Volatile Organic Compounds StandardI. SCOPE

The purpose of this procedure is to define the standardization of the gas chromatograph for reference in the quantitative analysis of samples containing unknown amounts of Volatile Organic Compounds.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Gastight syringes 1000ul, 250ul, 100ul.
3. Pure compounds (CAUTION: Some VOC's are known carcinogens and should be handled with care to avoid possible contamination.)
4. Gas sampling bulb 1000ml size

III. PROCEDURESCalibration using pure VOC to make gas standard

1. Run a blank of the syringe and 1 liter gas sampling bulb to be used.
2. Inject a known volume of the liquid VOC (or of an equal volume mixture of several compounds of interest) into the 1 liter bulb (verify actual bulb volume beforehand). This is on the order of 1 ul for 100 to 300 ppm levels.
3. Allow the liquid to vaporize and disperse throughout the bulb. This may take 5-10 minutes depending on volatility of the compounds. See precautions.
4. Using a gastight syringe, withdraw a 100-1000ul sample from the bulb and inject it into the GC. Volume utilized should approximate expected field concentrations.
5. Calculation of concentration:

$$\text{mg/L} = \frac{\text{sp.gravity} \times \text{liq.vol} \times \% \text{purity} \times \text{inj.volume (ul)}}{\text{bulb volume} \times 100\% \times 1000\text{ul}}$$

6. If not within 10% of previous calibration, repeat 4&5. Otherwise maintain calibration values established.
7. Calibrate to new values when repeatability is shown. See precautions.

#### IV PRECAUTIONS


1. In injecting headspace vapor from pure compound, care must be taken not to overload the column.
2. A wide change in calibration values indicates that troubleshooting of the system or procedures is necessary.
3. In using a liquid, be sure the volume injected will be well below vapor saturation for the bulb volume used.
4. Examine the bulb for any droplets or condensation that may indicate incomplete vaporization of the liquid. Some warming of the bulb (i.e., sunlight, rubbing with a cloth, even the CC oven briefly) may hasten the process. The less volatile the compound, the more problem this becomes.
5. Do not rely on the bulb's integrity for more than an hour.

**ATTACHMENT 3**

## ERM-North Central, Inc.

### MEMORANDUM

TO: Don Smith - ECC Technical Committee  
Jerry Amber - ECC Technical Committee

FROM:  Roy O. Ball, ERM-North Central, Inc.

DATE: August 30, 1988

RE: Vapor Extraction Design Criteria and  
Preliminary Cost Estimate

### INTRODUCTION

This report details the design criteria which were derived from the TERRA VAC Pilot Test conducted from June 13, 1988 to July 20, 1988, at the ECC site. Two horizontal and two vertical extractions trenches were constructed. The design criteria described herein were developed from HEW-2, one of the two horizontal extraction trenches.

### DESIGN COMPONENTS

The vapor extraction system includes the following cost elements:

1. Site preparation
2. Trench construction
3. Vapor extraction and ground water piping
4. Trench backfill and capping



## **ERM-North Central, Inc.**

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5. Vapor extraction manifold system
6. Vapor extraction blower, motor and controls, including moisture trap
7. Exhaust vapor treatment
8. Exhaust vapor stack and monitoring system

Each of these elements is discussed in more detail below. The estimated costs for each of these elements are presented on Table 1 and the basis for those costs are presented on Table 2.

### **SITE PREPARATION**

Site preparation includes the following cost items:

- o Verification of security.
- o Minor surface leveling and relocation of moveable objects to simplify vapor extraction layout.
- o Three-phase, 440 volt electrical service to blower motor location.
- o Construction of 20' x 20' concrete pad for blower emission control system.
- o Mobilization of site trailer and minor utilities.

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The capital cost for this element is \$20,000. The expected operating cost for the first year of operation is \$10,000.

### **TRENCH CONSTRUCTION**

Trenches will be constructed to the same cross-section as the Pilot Test, i.e., 1.5 feet in width and 9 feet in depth. Trenches will be dug by a conventional backhoe using a narrow width bucket. The dirt will be placed directly in a lined, light dump truck and/or stockpiled for removal by a front-end loader. The excavated dirt will be placed in windrows on the existing concrete pad for subsequent vapor extraction (Area 3 on the attached Figure). In all, a maximum of 1,800 cubic yards is expected to be excavated. The attached Figure 3 indicates the general layout of the vacuum extraction system. The Area 1 and Area 2 trenches will be 150 feet and 100 feet in length, respectively, with a 35-foot separation. Area 3 will have two trenches 200 feet in length located 80 feet apart extending under the concrete pad.

There is no capital cost for this element. The expected operating cost for the first year of operation is \$10,000.

### **VACUUM EXTRACTION AND GROUND WATER PIPING**

The trenches will be excavated to the 9-foot level, with a minimum 1-foot width. A 4-inch slotted PVC pipe will be placed at the 8-foot level to drain off any ground water that may accumulate within the vapor extraction trenches. This pipe will be connected to a 4-inch PVC riser which will be manifolded at

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the surface and connected to a positive displacement pump, as necessary, for water removal. The vapor extraction pipe will be located at the 6-foot level and will consist of 50 feet each of 6, 8 and 10-inch slotted PVC pipe. The pipe size is selected to have a maximum velocity of 40 feet per second (fps) before transition to the next section. The pipe will be connected via a 10-inch riser to the surface for connection to the above ground vacuum manifold.

The capital cost for this element is \$70,000. The expected operating cost for the first year of operation is \$6,000 (for water removal, if necessary).

### **TRENCH BACKFILL AND CAPPING**

As part of installation of the piping system the ground water and vapor collection pipes will be bedded in washed pea gravel. The trench will be filled to the 5-foot level with pea gravel which will be covered with a 30 mil or greater polyethylene liner. A one-foot thick bentonite seal will be constructed on top of the liner using hydrated bentonite pellets. The trench will be filled to grade (approximately 4 feet) with a cement grout mixture to prevent infiltration of surface water and vacuum breakthrough to the surface. The capital cost for this element is \$40,000. The first year operating cost for this element is \$12,000.

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### **ABOVE GROUND VACUUM MANIFOLD**

Because of the high vapor flow rates, the trench vapors will likely be collected in an above ground manifold. The manifold will be appropriately insulated and will change in size from 1' x 1.25' at the start of the manifold system to a nominal 3' x 3' at the connection to the blower plenum. The blower plenum will be designed to receive 25,000 SCFM at a nominal 4' x 4' size. The surface manifold will be sloped to allow the removal of any condensation which may form.

The capital cost for this element is \$15,000. The expected operating cost for the first year of operation is \$6,000 (for condensation handling/repair, if necessary).

### **VAPOR EXTRACTION BLOWER MOTOR AND CONTROL SYSTEM**

The vapor extraction blower motor and control system will be capable of removing a nominal 25,000 SCFM against a resistance of 3" Hg (approximately 400 HP). The Pilot Test indicates a steady-state soil resistance (after initial extraction development) of 2-1/2" Hg. The piping and manifold system will be designed for a maximum resistance of 1/2" Hg. The controls will consist of motor control and starter with automatic shut-off in the event of: 1) excessive condensation in the vacuum system; 2) high or low suction pressure levels; and 3) failure of the air pollution control systems.

The capital cost for this element is \$100,000. The expected operating cost for the first year of operation is \$200,000.

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### **EXHAUST VAPOR TREATMENT SYSTEM**

The exhaust vapor treatment system is expected to consist of granular activated carbon columns operating at a nominal capacity of 1000 SCFM. The carbon will remove between 200-300 lbs of VOC depending upon the compounds extracted. If two blowers are utilized, each will connect to 12 columns via an exhaust manifold. The 24 columns should provide enough capacity to adsorb all of the extracted organics. When the vapor extraction process is complete the adsorbed vapors will be thermally destroyed on the columns during on-site contaminant destruction/carbon regeneration.

The capital cost for this element is \$50,000. The expected operating cost for the one year of operation is \$300,000.

### **EXHAUST VAPOR STACK AND MONITORING SYSTEM**

The exhaust vapor from the carbon columns will be manifolded to a stack with a nominal height of 20 ft. and a nominal diameter of 2.5 feet. The plenum connecting the carbon columns to the stack will have ports so that samples of exhaust vapor can be collected for subsequent analysis for volatile organic compounds.

The capital cost for this element is \$30,000. The expected operating cost for the first year of operation is \$60,000 (analytical).

## ERM-North Central, Inc.

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### COST SUMMARY

The attached tables summarize the capital and first year operating cost for each of the eight major cost elements. The expected total capital cost is estimated to be \$325,000 and the expected total first year operating cost are estimated to be \$604,000. These figures are preliminary in nature with an expected accuracy of +50/-25%. Please note that the total costs include a 20% allowance for engineering, 15% for project management during the first year of operation, and a 25% contingency.

### EXPECTED DURATION OF THE VAPOR EXTRACTION SYSTEM OPERATION

The Pilot Test indicated an initial removal rate of 75 lb. of VOC per day, and a rate of 9.9 pounds per day at the end of the Pilot Test. The extraction rate appeared well-behaved and can be represented with a first order rate equation. The equation shown below provides a good fit to the HW-2 Pilot Test data:

$$R_t = R_0 e^{-k_1 t}$$

Where

- $R_t$  = rate at time  $t$ , lb/day/ft of trench
- $R_0$  = rate at time 0, lb/day/ft
- $k_1$  = rate constant, day<sup>-1</sup>
- $t$  = time, day

## **ERM-North Central, Inc.**

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TERRA VAC has estimated that essentially complete removal will occur within one year of operation. The exact duration of the operation will be determined by a risk based analysis of the residual contamination. It appears, therefore, that one year should represent a maximum duration of operation for the system, and has been selected to characterize the operational cost. In the event the system is operated for less than one year, the operational costs can be discounted in direct proportion to the actual duration.

cc: Norman Bernstein - ECC Steering Committee  
Timothy Harker - ECC Steering Committee

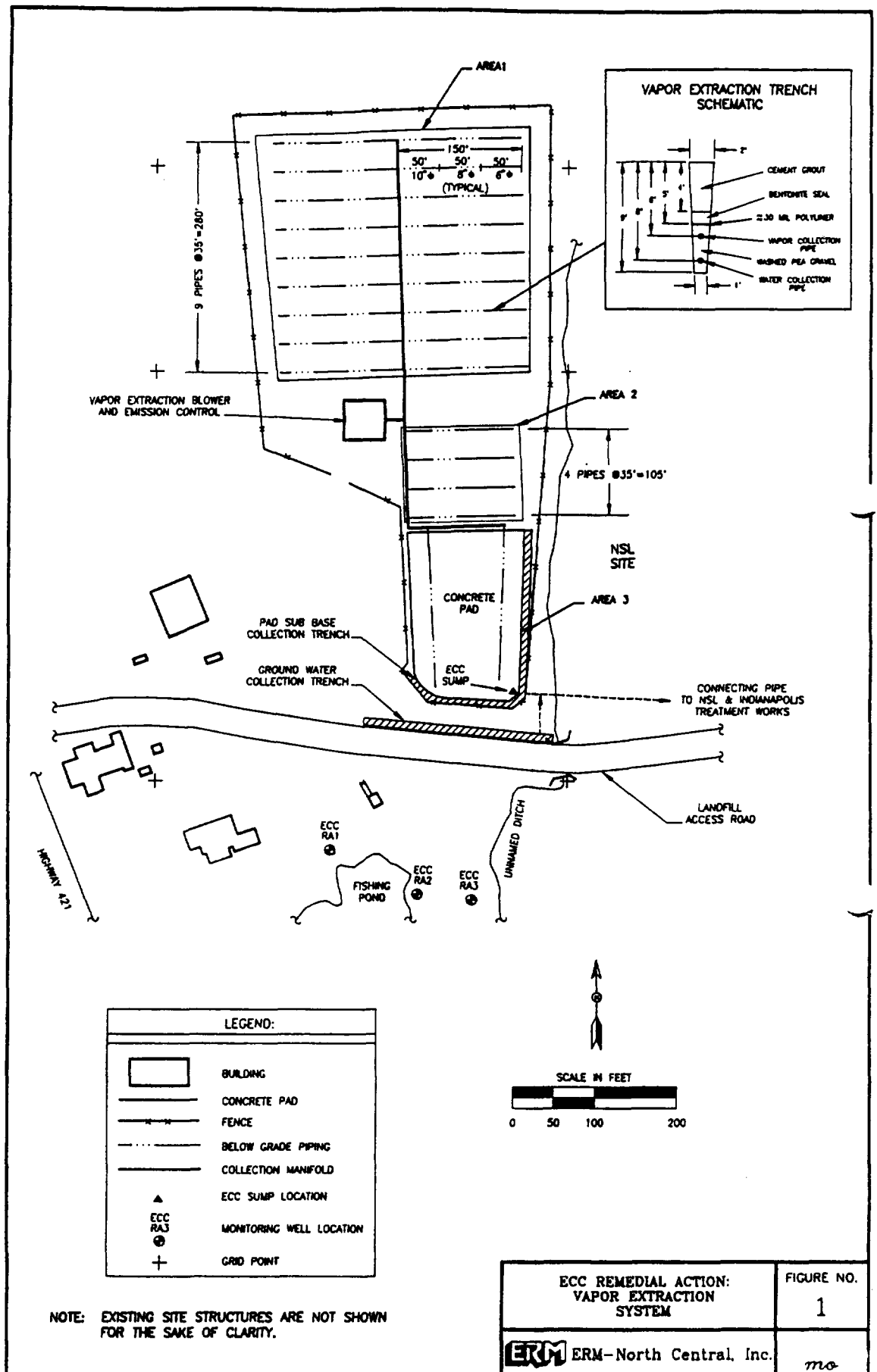
TABLE 1  
VAPOR EXTRACTION  
PRELIMINARY COST ESTIMATE  
(x \$1000)

<u>Cost Element</u>	<u>Capital</u>	<u>1 Year of Operation</u>
1. Site Preparation	20	10
2. Trench Construction	0	10
3. Vapor Extraction Water Piping	70	6
4. Trench Backfill and Capping	40	12
5. Vapor Extraction Manifold System	15	6
6. Vapor Extraction Blower, Motor, Controls	100	200
7. Exhaust Vapor Preconcentration and Destruction	50	300
8. Exhaust Vapor Stack & Monitoring	<u>30</u>	<u>60</u>
	325	604
Engineering/Design	65	Proj.Mgmt. 90
Contingency	<u>98</u>	Contingency <u>174</u>
	488	868



**TABLE 2**  
**VAPOR EXTRACTION**  
**PRELIMINARY COST BASIS**

<u>Cost Element</u>	<u>Capital</u>	<u>Operation</u>
1. Site Preparation	Lump Sum	Lump Sum
2. Trench Construction	0	2000 cu.yd at \$5/cu.yd
3. Vapor Extraction Water Piping	3500 L.F. @ \$20/L.F.	\$500/mo. for 12 mo.
4. Trench Backfill and Capping	2000 cu.yd. @ \$20/cu.yd.	\$1000/mo. for 12 mo.
5. Vapor Extraction Manifold System	300 L.F. @ \$50/L.F.	\$500/mo. for 12 mo.
6. Vapor Extraction Blower, Motor, Controls	Lump Sum	\$130,000 electricity @ \$0.05 KWH  \$ 70,000 maintenance
7. Exhaust Vapor Preconcentration and Destruction	Lump Sum	5500 lbs. VOCs Carbon @ \$3/lb @ 0.1 capacity Subsequent thermal destruction
8. Exhaust Vapor Stack & Monitoring	Lump Sum	\$5000/mo. for 12 mo.



NOTE: EXISTING SITE STRUCTURES ARE NOT SHOWN FOR THE SAKE OF CLARITY.



**ERM-North Central, Inc.**

Environmental Resources Management

102 Wilmot Road • Suite 300 • Deerfield, Illinois 60015 ☎ (312) 940-7200

November 3, 1988

Elizabeth Maxwell  
Office of General Counsel  
U.S. Environmental Protection Agency  
Region V  
230 South Dearborn Street  
Chicago, IL 60604

RE: ECC Remedial Action Work Plan

Dear Ms. Maxwell:

As instructed by the ECC Steering Committee, enclosed please find one (1) copy of the Confidential Preliminary Draft for Settlement Purposes Only of the Remedial Action Work Plan for the Environmental Conservation and Chemical Corporation (ECC) site at Zionsville, Indiana

Very truly yours,

ERM-NORTH CENTRAL, INC.

*Roy Ball* /ERM

Roy O. Ball, Ph.D., P.E.  
Principal

jls

Enclosures

cc: M. Grummer  
K. Vendl  
A. Sloan  
J. Buck  
D. Smith  
J. Amber  
N. Bernstein  
T. Harker

**CONFIDENTIAL PRELIMINARY DRAFT  
FOR SETTLEMENT PURPOSES ONLY**

**REMEDIAL ACTION WORK PLAN  
DETAILED ANALYSIS**

**ENVIRONMENTAL CONSERVATION AND  
CHEMICAL CORPORATION (ECC) SITE  
ZIONSVILLE, INDIANA**

**NOVEMBER, 1988**

**PREPARED FOR:**

**ECC SETTLERS STEERING COMMITTEE**

**PREPARED BY:**

**ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, ILLINOIS 60015**

**PROJECT NO. 8076**

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REMEDIAL ACTION WORK PLAN  
DETAILED ANALYSIS

ENVIRONMENTAL CONSERVATION AND  
CHEMICAL CORPORATION (ECC) SITE  
ZIONSVILLE, INDIANA

1.0 INTRODUCTION

This is a Remedial Action Work Plan (RAWP) for the ECC Site. The RAWP addresses all environmental concerns regarding the site, namely:

- o direct contact with soils containing volatile organics (VOCs), semivolatile organics, and heavy metals;
- o contamination of ground water by rain water percolating through soils containing VOCs, semivolatile organics, and heavy metals;
- o contamination of surface waters by overland migration of water in contact with soil containing VOCs, semivolatile organics, and heavy metals;
- o ingestion of ground water containing VOCs, semivolatile organics, and heavy metals; and



- o contamination of surface waters by discharge of ground water containing VOCs, semivolatile organics and heavy metals.

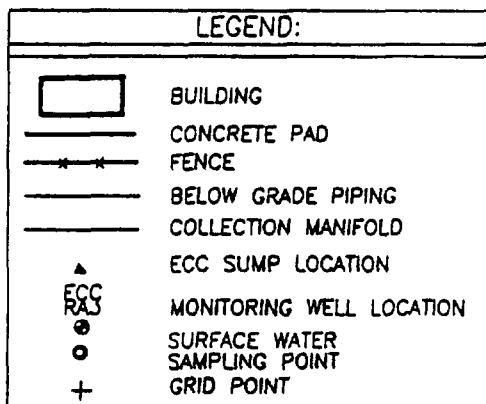
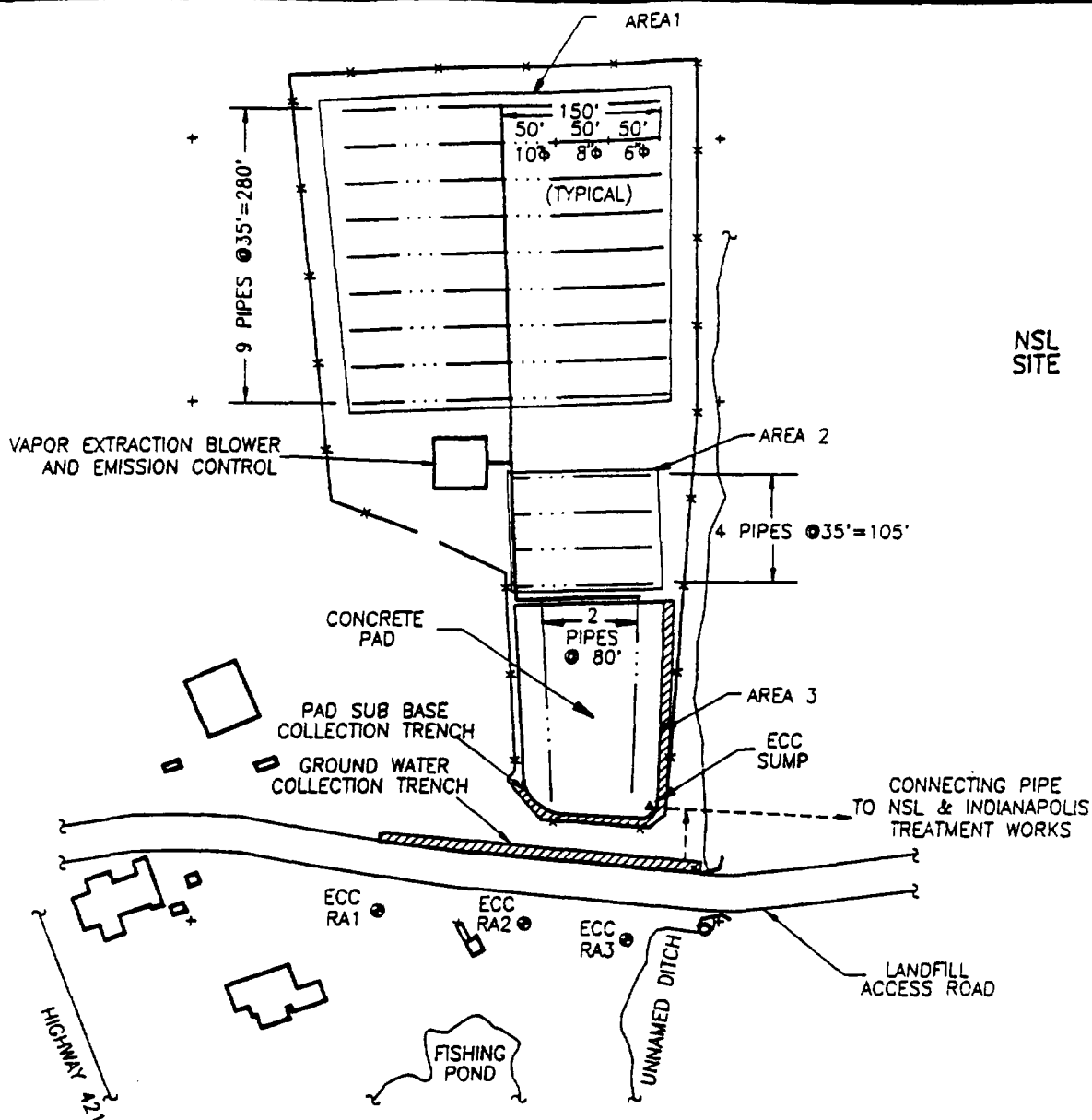
Additionally, the RAWP most closely complies with the Superfund Amendments and Reauthorization Act (SARA) of 1986 by removing VOCs from the soils and destroying them.

The RAWP includes the components listed below (Figure 1):

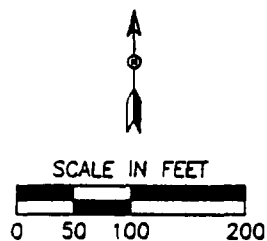
- o soil vapor extraction, concentration and destruction;
- o soil cover;
- o diversion of surface water runoff upgradient of concrete pad and collection of water from beneath the concrete pad;
- o shallow saturated zone ground water interception and collection;
- o access restrictions; and
- o ground water and surface water monitoring.

The following sections present for each component: (1) description and technical basis, (2) objectives, and (3) performance standards which would be utilized to evaluate their effectiveness. A schedule for implementation of the work plan is also presented.

Although the detailed design of the Northside Sanitary Landfill (NSL) remedial action plan has not been finalized, the plan



NOTE: EXISTING SITE STRUCTURES ARE NOT SHOWN FOR THE SAKE OF CLARITY.



ERM	ERM-North Central, Inc.	ECC REMEDIAL ACTION PLAN SCHEMATIC	FIGURE 1
		10/27/88	CS

presented herein is compatible with the proposed remedy for the NSL site. If necessary, modifications to the design will be done to merge both remedies appropriately.

## 2.0 SOIL VAPOR EXTRACTION, CONCENTRATION AND DESTRUCTION

### Objectives

- o remove and destroy existing VOCs from the soils (as provided herein) and thereby:
  - 1) prevent contact with contaminated soils, if any;
  - 2) prevent migration of contaminants, if any, from the soils to the ground water; and
  - 3) prevent migration of contaminants, if any, from the ground water to the surface water.

### Description

Soil vapor extraction would remove existing VOCs from the soils by enhancing and accelerating volatilization.

To accomplish this, pipelines would be installed in trenches dug in the soils. The vacuum pressure developed by the extraction system will cause the VOCs in the soils to migrate to the pipelines and into the vapor treatment system. The vacuum is provided by a blower. The vapor treatment system would consist of preconcentration of the VOCs by adsorption on activated carbon and destruction of the VOCs by incineration.

The effectiveness of vapor extraction for VOC removal from the soils was demonstrated during a pilot test run by Terra Vac in June 1988 (Appendix A). The test showed an initial high VOC extraction rate of about 1.9 lb/d per foot of trench that decreased with time to a steady-state rate of about 0.25 lb/d per foot of trench.

Prior to startup of construction of the vapor extraction system, the following activities would be conducted:

- o level out the site's surface;
- o relocate movable objects;
- o provide three-phase, 440 volt electrical service;
- o construct a 20' x 20' concrete pad for the blower emission control system; and
- o mobilize a trailer and minor utilities.

The trenches would have the same cross-section as in the pilot test, i.e., a minimum of 1 foot in width and a total of 9 feet in depth. Under the concrete pad, the depth of the vapor extraction trench would be reduced to 5 feet, because the concentrations of compounds detected in the soils are below the acceptable remaining soil concentrations calculated below (see page 7).

As shown in Figure 1, the site has been divided into three separate areas based on the site dimensions. The layout of the vacuum extraction system is also presented in Figure 1. The Area 1 and Area 2 trenches would have a 35-foot separation, based on a radius of influence of 15 to 20 feet found during the pilot test

(Appendix A). The trench separation beneath the concrete pad would be 80 feet, assuming that the radius of influence would double in the subbase of the concrete pad, which has a higher permeability than the shallow till. The length of the trenches would be 150 feet, 100 feet and 200 feet in Areas 1, 2, and 3, respectively, based on the dimensions of each zone.

Trenches would be dug by a conventional backhoe using a narrow width bucket. The dirt would be placed directly in a lined, light dump truck and/or stockpiled for removal by a front-end loader. The excavated dirt would be placed in windrows on the existing concrete pad for subsequent vapor extraction (Area 3 on Figure 1) installing an extraction pipe at the bottom of the windrows and connecting it to the vapor extraction system. The trenches under the concrete pad would be laid on the pad's subbase and dug in a similar way. The concrete debris would be placed on top of the concrete pad and leveled out. A maximum of 1800 cubic yards is expected to be excavated during trench construction.

A 4-inch slotted PVC pipe would be placed at the 8-foot level within the trenches to drain off any ground water that may accumulate in the trenches. This pipe would be connected to a 4-inch PVC riser which would be manifolded at the surface and connected to a positive displacement pump for water removal and discharge to the ground water interception system.

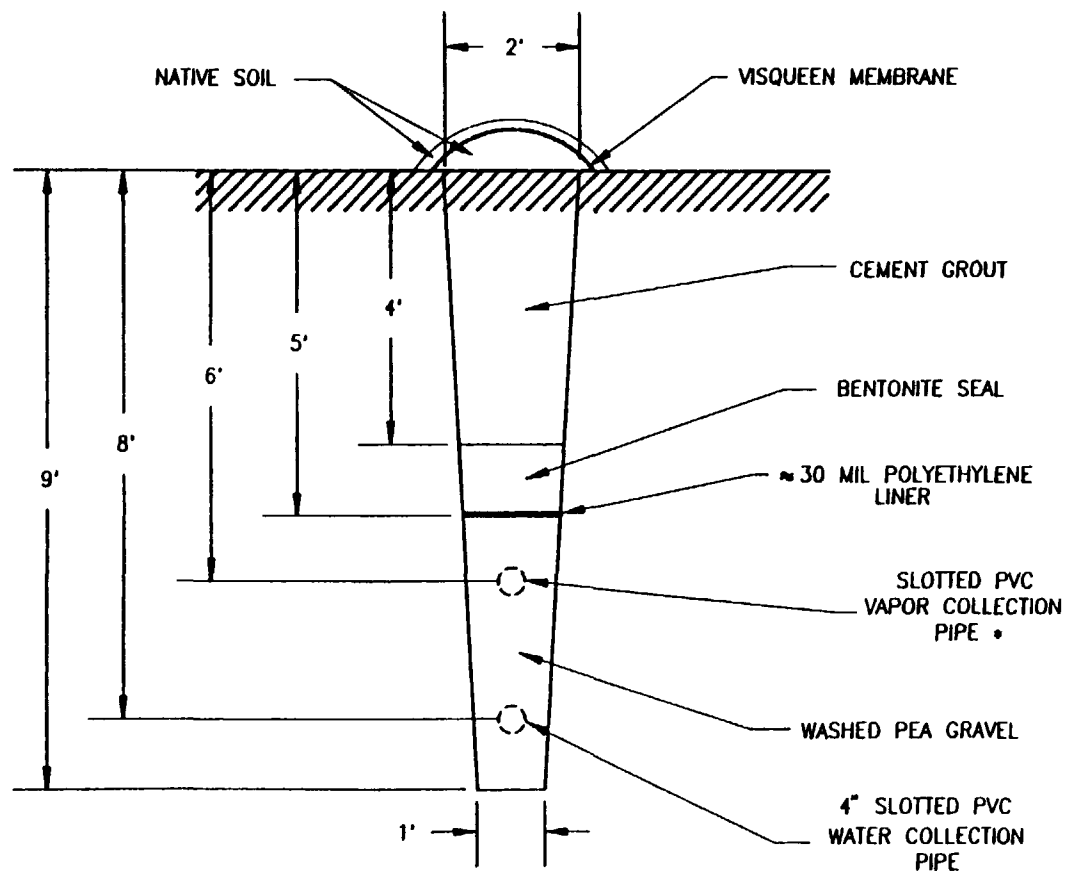
The vapor extraction pipe would be located at the 6-foot level and would consist of 50 feet each of 6-, 8- and 10-inch slotted PVC pipe. The pipe size was selected to have a maximum velocity of 40 feet per second (fps) before transition to the next section. The pipe would be connected via a 10-inch riser to the surface for connection to the above ground vacuum manifold.

The trenches would be filled to the 5-foot level with pea gravel, which would be covered with a 30 mil or greater thickness polyethylene liner. A one-foot thick bentonite seal would be constructed on top of the liner using hydrated bentonite pellets. The trench would be filled to grade (approximately 4 feet) with a cement grout mixture and slightly mounded with native soil and visqueen membranes to prevent infiltration of surface water and vacuum breakthrough to the surface (Figure 2).

The vapor extraction trenches underneath the concrete pad would be modified as follows: (1) the water and vapor extraction pipes would be located at the 4-foot and 3-foot level, respectively; (2) the trench would be filled to the 2-foot level with pea gravel, covered with a 30-mil liner and filled to the one-foot level with a bentonite seal; and (3) the trench would be filled to grade and slightly mounded with a cement grout mixture.

The trench vapors would be collected in an above ground manifold. The manifold would be insulated and would change in size from 1' x 1.25' at the start of the manifold system to a nominal 3' x 3' at the connection to the blower plenum, to accommodate the increased flow of vapors. The blower plenum would be designed to receive 25,000 SCFM at a nominal 4' x 4' size. The surface manifold would be sloped to allow the removal of any condensation which may form. The water collected in the condensation trap would be combined with the water collected in the trenches and conveyed to the Indianapolis sewage treatment system (see Section 5).

The vapor extraction blower motor and control system would be capable of removing a nominal 25,000 SCFM against a resistance of 3" Hg (equivalent to about 400 HP). After initial extraction development during the pilot test, a steady-state soil resistance of 2-1/2" Hg was measured. Therefore, the piping and manifold system would be designed for a maximum resistance of 1/2" Hg (a



• SIZE VARIABLE, DEPENDING ON  
LOCATION (SEE FIGURE 6)

NOTE: NOT TO SCALE

ECC REMEDIAL ACTION PLAN  
VAPOR EXTRACTION  
TRENCH SCHEMATIC

FIGURE  
2

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higher vacuum). The controls would consist of motor control and starter with automatic shut-off in the event of: (1) excessive condensation in the vacuum system; (2) high or low suction pressure levels; and (3) failure of the VOC adsorption/concentration system.

The exhaust VOC adsorption/concentration system would collect the VOCs extracted from the soil and would consist of three 12-foot diameter unlined carbon steel vessels, each holding approximately 13,600 pounds of granular activated carbon. This is based on: (1) a flow rate of 25,000 SCFM; (2) concentrations of trichloroethylene (TCE) and 1,1,1-trichloroethane (TCA) in the vapors of 34 ppmv and 16 ppmv, respectively, as detected during the pilot test; (3) a carbon capacity for these two compounds of about 25% by weight; and (4) an assumed total mass of VOCs of about 5,500 pounds. This carbon system would be able to handle the entire mass of VOCs extracted from the soils during the remediation. Based on the soil samples collected during the RI, it was estimated that about 4,700 lb of VOCs were present in the soils (Table 1). Therefore, the amount of carbon in the system is about 20% more than the theoretical required amount.

After vapor extraction is completed, the spent carbon containing the extracted VOCs would be transported to a licensed off-site RCRA facility. At the facility, the VOCs would be stripped and destroyed and the carbon regenerated by high temperature incineration.

Samples of the extracted vapor and the exhaust vapor would be collected daily during the first week of operation, weekly for the following 4 weeks, and monthly thereafter. Samples would be analyzed for VOCs. Also, flow rate would be monitored and recorded, to provide enough data to calculate the mass of VOCs removed from the soils.



TABLE 1  
ECC REMEDIAL ACTION PLAN  
ESTIMATE OF VOC MASS IN THE SOILS \*

Location	Sampling depth ft	Assumed contamination depth, ft	Total VOCs concentration ug/kg	Mass of VOCs lb
-----	-----	-----	-----	-----
TP-1	1 - 1.5	2	102	0.014
TP-2	1 - 1.5	2	28	0.004
TP-3	1 - 1.5	2	107,700	14.827
TP-4	1 - 2	2.5	97,330	16.749
TP-4	2.5 - 3.5	4	16	0.004
TP-5	1 - 2	2	22,587	3.109
TP-5	2 - 3	1.5	291	0.030
TP-6	1 - 2	2	10,505,000	1,446.173
TP-6	2 - 3	1.5	22,450	2.318
TP-6	4 - 5	1.5	16	0.002
TP-7	1 - 2.5	2.5	231,000	39.751
TP-7	2.5 - 4	2	279,200	38.436
TP-8	1 - 2.5	2.5	67	0.012
TP-8	2.5 - 4	2	315,600	43.447
TP-9	1 - 3	3	14,604,000	3,015.694
TP-9	3 - 5	2.5	130	0.022
TP-10	1 - 3	3	108	0.022
TP-10	3 - 5	2.5	92	0.016
TP-11	1 - 3	3	130	0.027
TP-11	3 - 5	2.5	67	0.012
TP-12	1 - 3	3	34,690	7.163
TP-12	3 - 5	2.5	3,609	0.621
SB-01	2.5 - 4	3	3,303	0.682
SB-02	2.5 - 4	3	12,900	2.664
SB-03	2.5 - 4	3	70,070	14.469
SB-04	2 - 3.5	2.5	175	0.030
SB-06	2 - 3.5	2.5	220,900	38.013
SB-08	2.5 - 4	3	3,012	0.622
SB-09	2.5 - 4	3	60,390	12.470
SB0104	5.5 - 7	2	27	0.004
SB0204	5.5 - 7	2	34	0.005
SB0403	5 - 6.5	2	51	0.007
SB0805	7 - 8.5	2	188	0.026
SB0904	5.7 - 7	2	8,069	1.111
TOTAL VOCs, lb				4,698.555

\* The area contaminated is assumed to be a 25'x25' square around each sampling location. TP = test pit; SB = soil boring.  
Soil concentrations from ECC RI.

The time required for soil treatment has been estimated by calculating acceptable remaining concentrations using the procedures detailed in the Endangerment Assessment Section and Appendix E of the RI. Table 2 presents the maximum and average concentrations of indicator VOCs (TCE, tetrachloroethylene (PCE), chloroform and methylene chloride) as detected in the soil samples during the RI investigation. The values presented in Table 2 are very conservative considering that access restrictions would be maintained and a cover placed on the site.

At the acceptable concentrations presented in Table 2, leaching of the compounds, if any, to the ground water and subsequent transport to the surface water would result in a risk at least two orders of magnitude lower than the predicted risk shown in Table 6-13 of the RI.

As shown in Table 2, TCE and PCE are the most significant indicators. Therefore, only the time required to remove these two compounds was calculated. During the pilot tests (Appendix A), the steady state removal rates of trichloroethene and tetrachloroethene were 0.1 lb/day per foot of trench and 0.02 lb/day per foot of trench, respectively. Both compounds were detected at the highest concentration in trench TP-6, at a depth of 1-2 ft.

In order to estimate the duration of treatment, it was conservatively assumed that an area of 625 ft<sup>2</sup> around sampling locations has the same concentration of compounds, and therefore the mass of TCE at TP-6 is 660 lbs, and the mass of PCE at TP-6 is 90 lbs. For a 99.92% removal of TCE (Table 2), the current maximum mass would have to be reduced to 0.6 lb, which at a rate of 0.1 lb/day per foot of trench would take about 265 days (using a trench length of 25 ft crossing the area). Similarly, for PCE the required time would be about 180 days. If lower

TABLE 2

ECC REMEDIAL ACTION PLAN  
CALCULATION OF ACCEPTABLE REMAINING SOIL CONCENTRATIONS  
BASED ON DATA AND METHODOLOGY IN THE ECC RI

<u>Parameter</u>	<u>Compound (1)</u>			
	<u>TCE</u>	<u>PCE</u>	<u>CHLO</u>	<u>MECH</u>
Maximum concentration, ug/kg	4,800,000	650,000	2,900	310,000
Location of maximum concentration	TP6(1-2')	TP6(1-2')	SB02(2.5-4')	TP3(1-3')
Excess risk identified in Tables 2 and 4 of Appendix E of the ECC RI, maximum concentration (2)	1.2 E-3	3.0 E-4	2.6 E-6	2.5 E-6
Average concentration, ug/kg	354,300	52,900	370	32,800
Excess risk identified in Tables 2 and 4 of Appendix E of the ECC RI, average concentration (2)	8.8 E-5	2.4 E-5	3.4 E-7	2.7 E-7
Concentration for acceptable risk, calculated, (2) ug/kg	4,000	2,100	1,100	124,000
Required removal, %				
Maximum concentration	99.92	99.68	62	60
Average concentration	99.0	96.0	--	--

- (1) TCE = Trichloroethene  
PCE = Tetrachloroethene  
CHLO = Chloroform  
MECH = Methylene Chloride

- (2) Based on ingestion of 1 gram of soil per day by a 70 Kg person over period of 70 years (an intake rate of 0.013 g/Kg/d).

concentrations are present, the treatment duration would be reduced accordingly.

#### Performance Standards

The vapor extraction system would have completed its task when:

- o the exhaust vapors contain less than 1 ppmv of VOCs; and
- o the average concentrations of TCE, PCE, chloroform and methylene chloride in the soils, as determined by vapor measurements and calculations, are reduced to the following levels: TCE - 4000 ug/kg; PCE- 2100 ug/kg; chloroform - 1100 ug/kg; and methylene chloride - 124,000 ug/kg.

### 3.0 SOIL COVER

#### Objectives

- o prevent human contact with remaining contaminated soil, if any;
- o prevent contamination, if any, of surface runoff;
- o reduce the infiltration of water through the soils;
- o promote evapotranspiration;

- o promote drainage of rain water away from the site; and
- o mitigate erosion.

### Description

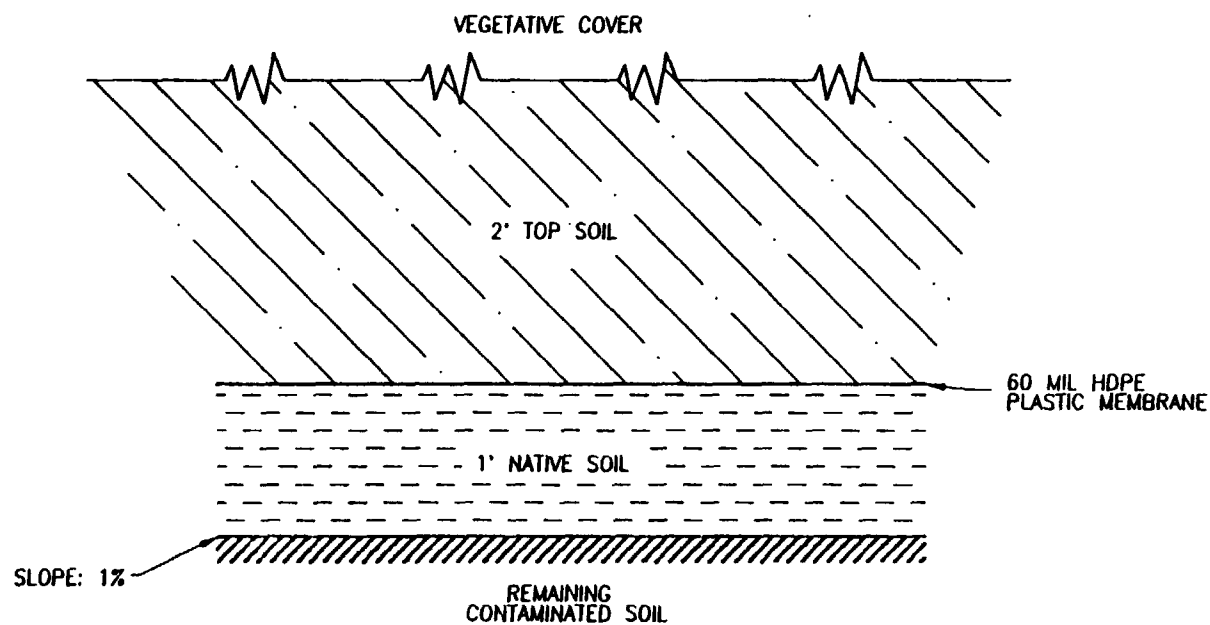
The soil cover would consist of a 0.5 foot layer of the highly impermeable native soil, 60 mil HDPE plastic membrane and a 2-foot layer of top soil to support vegetation (Figure 3).

Prior to placing the soil cover, the site would be graded to fill existing depressions and eliminate sharp grade changes and would be sloped at about 1% to promote drainage. Vegetation to be established would be characterized by fibrous, shallow, laterally growing roots, such as grass.

The cover would be installed over all the site, after soil remediation is completed. Approximately 5300 cubic yards (cy) of native soils, 21,000 cy of top soil and about 23,000 square yards of plastic membrane would be required.

### Performance Standards

- o the inflow of ground water to the various interception trenches would be reduced as a result of decreased infiltration;
- o erosion would be minimal; and
- o a vegetative cover would be present over the site.



ECC REMEDIAL ACTION PLAN  
CROSS SECTION OF SOIL COVER

FIGURE  
3

ERM ERM-North Central, Inc.

10/27/88  
CA

#### 4.0 DIVERSION OF SURFACE WATER RUNOFF UPGRADIENT OF CONCRETE PAD AND COLLECTION OF WATER FROM BENEATH THE CONCRETE PAD

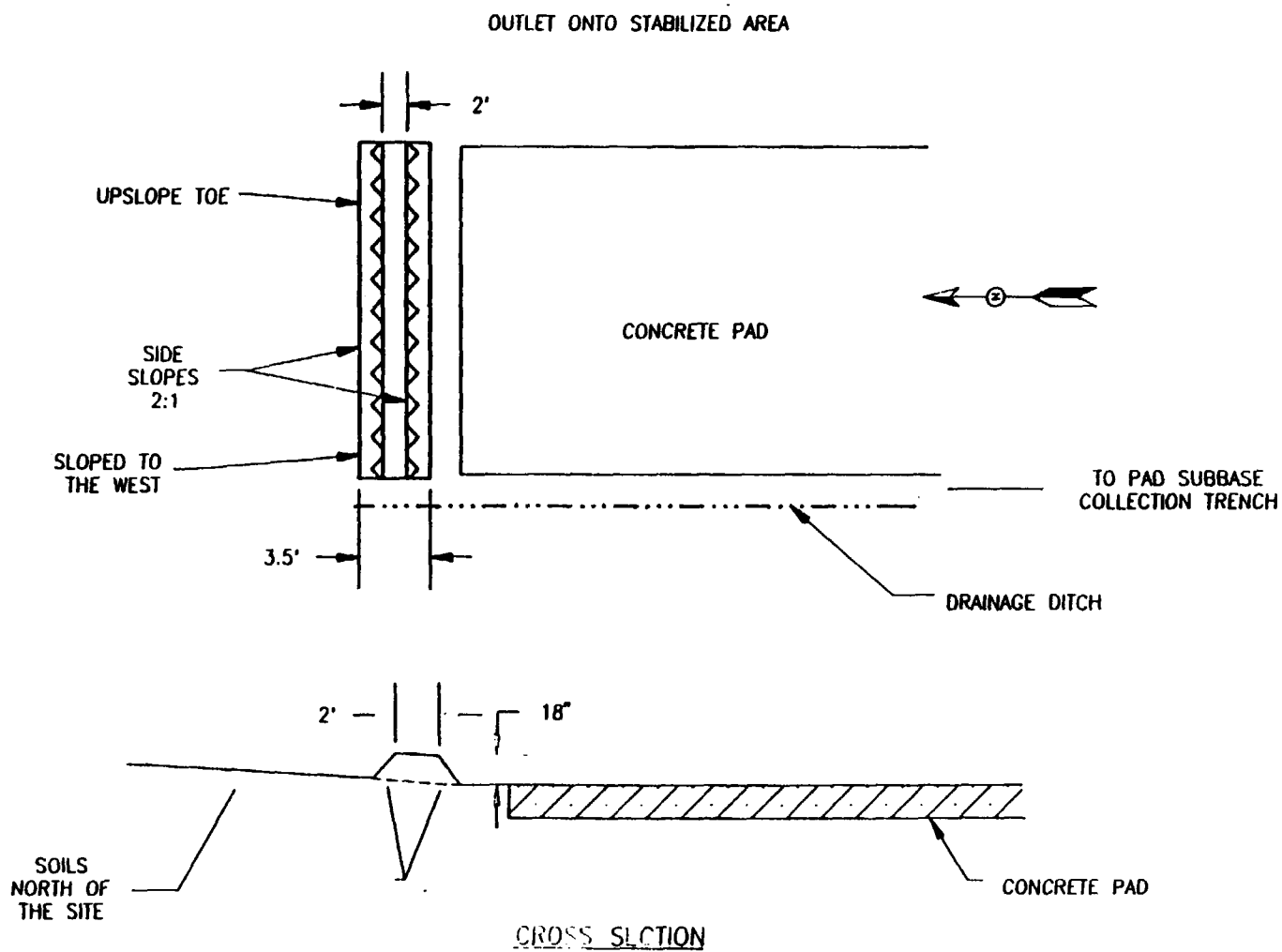
##### Objectives

- o prevent the infiltration of surface runoff beneath the concrete pad;
- o eliminate the concrete pad subbase as a migration route for contaminants, if any;
- o prevent contamination, if any, of the saturated surface till beyond the concrete pad; and
- o collect the water, if any, that may become contaminated through flow beneath the concrete pad.

##### Description

Surface water runoff from the northern part of the site largely flows south, where an existing berm along the north edge of the concrete pad redirects runoff to a drainage ditch west of the site. This berm would be repaired and/or reinforced to ensure that runoff cannot infiltrate beneath the concrete pad (Figure 4). This would essentially eliminate the generation of contaminated runoff into the USEPA - installed sump located at the south end of the pad.

An estimated 0.1 gpm would be diverted by this system, assuming a drainage area equal to 1/2 of the northeastern section of the site would drain towards the concrete pad (approximately 20,800 ft<sup>2</sup>), a runoff coefficient of 0.1 and a precipitation rate of 40 in/year.



NOTE: NOT TO SCALE

ECC REMEDIAL ACTION PLAN  
SURFACE WATER RUNOFF  
DIVERSION BERM

FIGURE

4

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CA



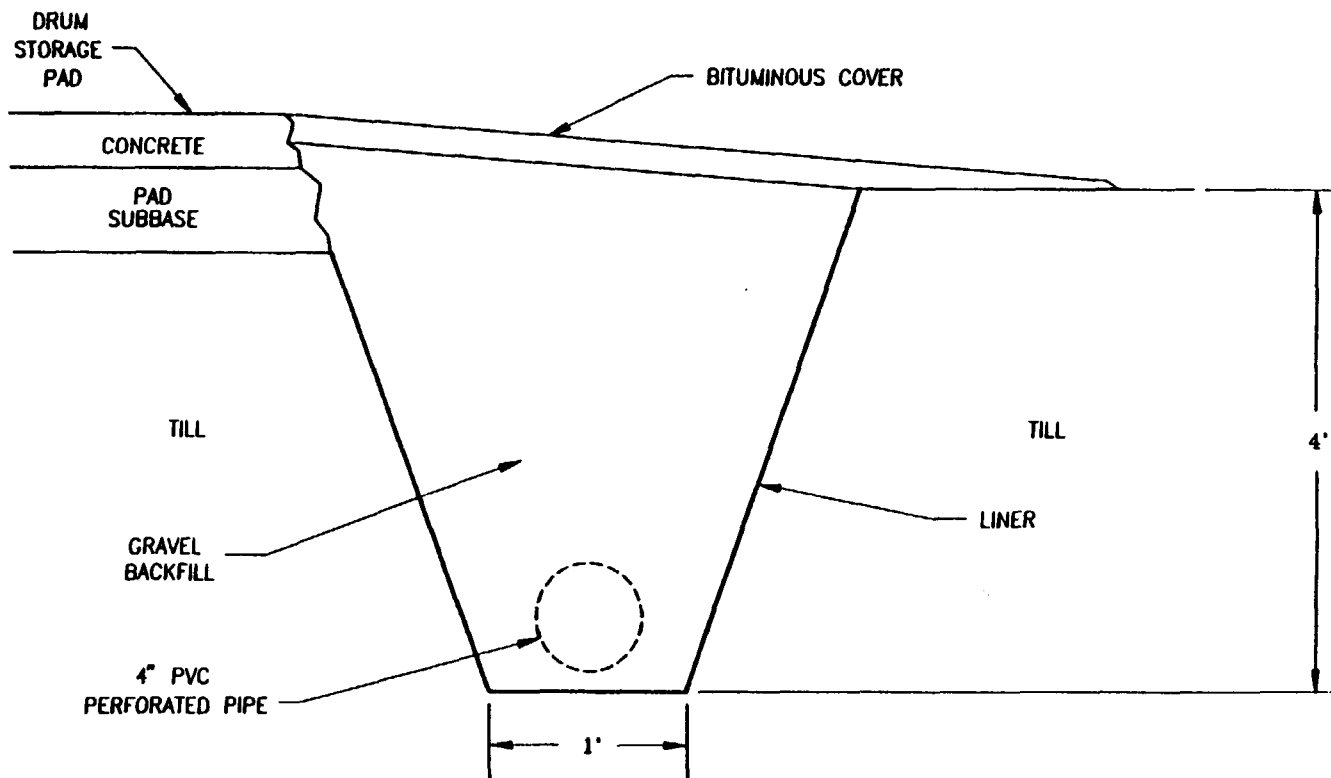
Prior to placement of the soil cover, the diverted surface runoff would be conveyed to the Indianapolis Wastewater Treatment Plant. Subsequent to cover placement, surface water runoff would be directed, as storm water runoff, to Finley Creek.

In addition to the diversion of surface runoff, a lined collection trench approximately 4 feet deep by 1 foot in width would be installed along the south and southeast portions of the concrete pad (Figure 5). The trench would be sloped to the southeastern corner of the pad. The water collected from this trench will be analyzed periodically, as presented in Section 5.0. The water would then be mixed with the rest of the water from the site and conveyed to the Indianapolis sewerage system for final treatment.

Once the surface water diversion system is installed, the amount of water flowing into this trench would be negligible. Initially, a flow of 0.6 gpm is estimated based on a precipitation of 40 in/yr, a 5% infiltration of rain water through cracks and around the edges of the pad, and a surface area of 27,300 ft<sup>2</sup>.

#### Performance Standards

- o minimal amounts of water would go beneath the concrete pad; and
- o contaminated water, if any, infiltrating beneath the pad would be collected in the trench.



NOTE: NOT TO SCALE

ECC REMEDIAL ACTION PLAN  
CONCRETE PAD DRAIN

FIGURE  
5

ERM ERM-North Central, Inc.

10/27/88

CA

## 5.0 SHALLOW SATURATED ZONE GROUND WATER INTERCEPTION AND COLLECTION

### Objectives

- o collect contaminated ground water, if any, from the saturated till escaping removal by soil aeration.

### Description

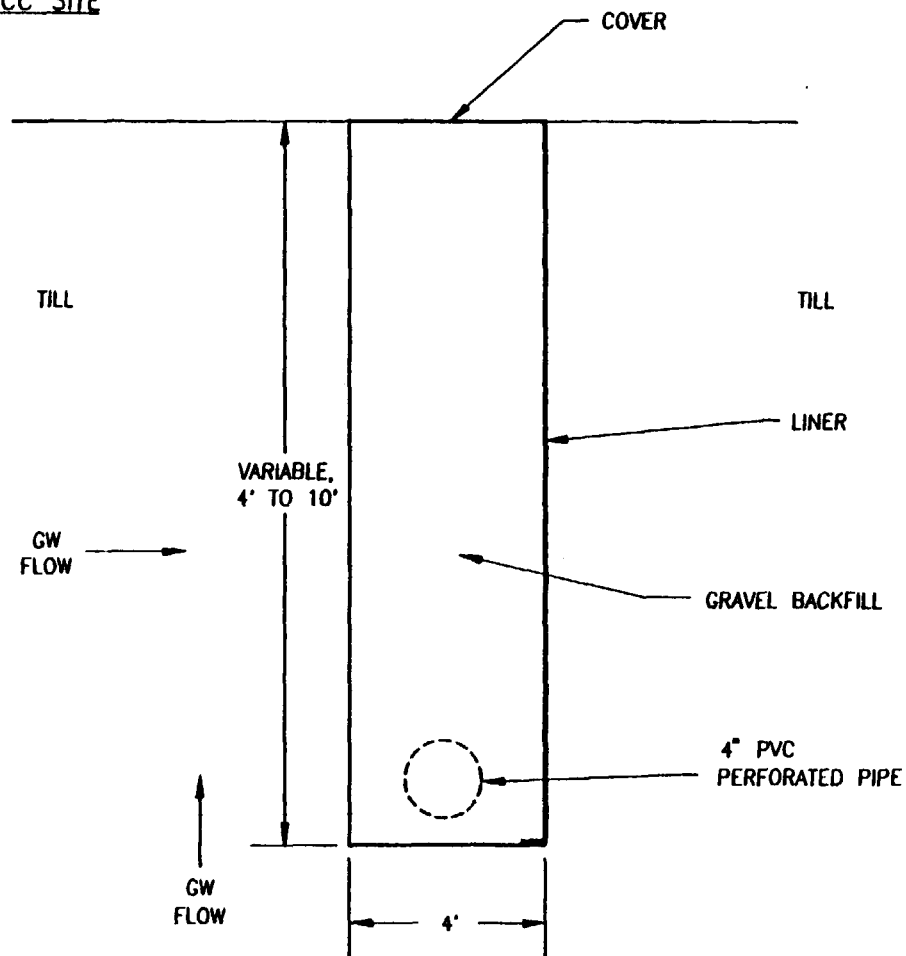
The ground water interception system would consist of a french drain extending east-west south of the ECC site along the north side of the NSL access road (Figure 1). The road would remain open at all times during construction and later operation of the french drain system. The drain would be approximately 330 feet in length, 4 feet in width and would be variable in depth depending upon till thickness.

A schematic of the trench components is shown in Figure 6. A cross-section of the trench is presented in Figure 7.

A 4-in PVC perforated pipe would be installed at the bottom of the trench. Gravel would be used for backfilling the trench. A plastic liner would be installed in the south and lower boundaries of the trench to prevent collection of uncontaminated, downgradient water (Figure 6).

The flow of water into the drain is estimated to be 0.70 gpm (Appendix B). Three components of flow were included: (1) regional ground water flow; (2) induced flow due to the trench; and (3) recharge due to precipitation and upward flow from the sand and gravel unit, which would be about 1 foot beneath the drain bottom.

ECC SITE



NOTE: NOT TO SCALE

ECC REMEDIAL ACTION PLAN  
GROUND WATER  
INTERCEPTION TRENCH

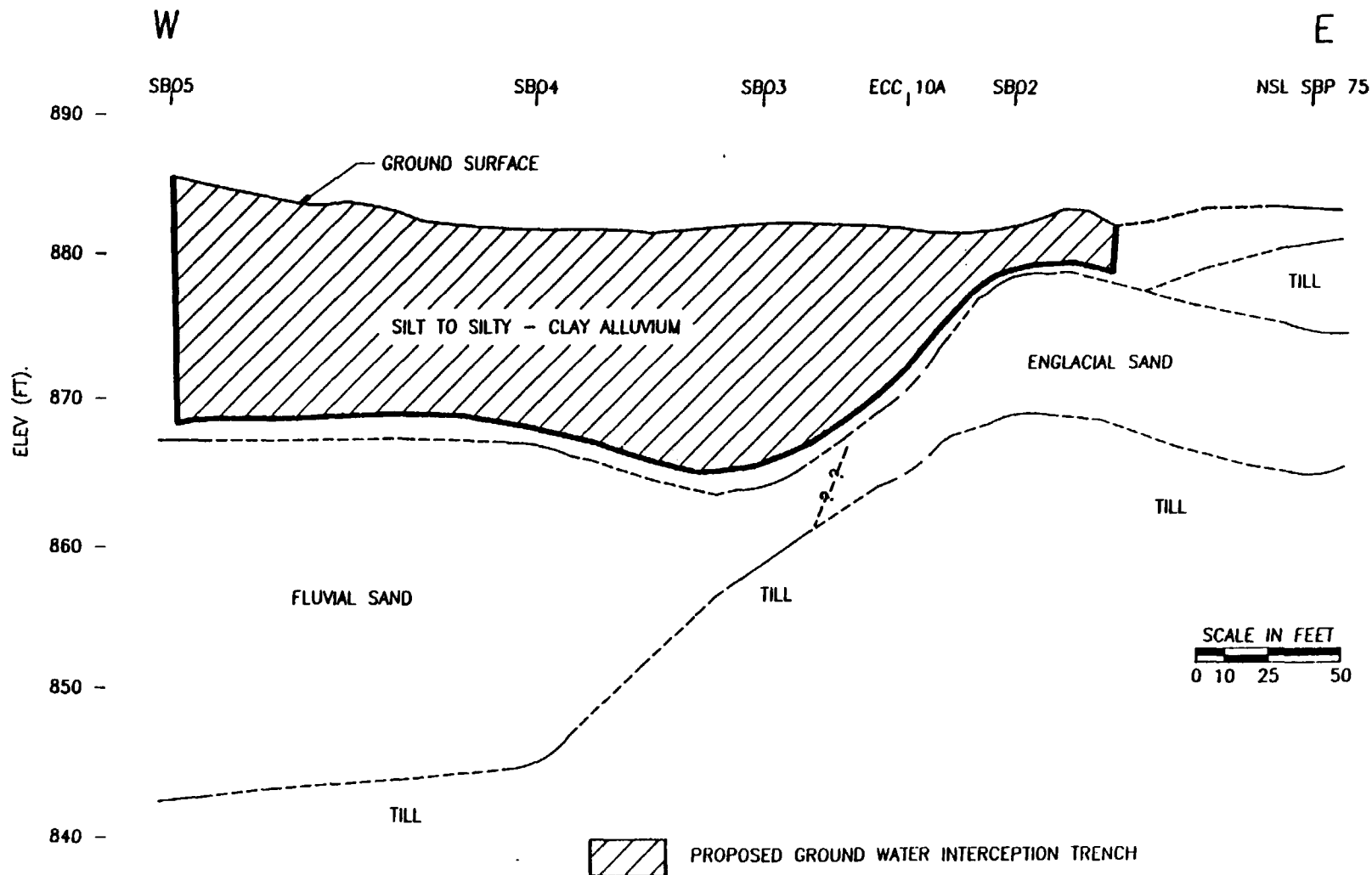
FIGURE

6

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10/27/88

CS



ADAPTED FROM: FIGURE 11A, CH2M-HILL, 1988  
DRAFT TECHNICAL MEMORANDUM NO. 2

GEOLOGIC CROSS-SECTION ILLUSTRATING LOCATION OF GROUND WATER INTERCEPTION TRENCH	FIGURE 7
ERM ERM-North Central, Inc.	10/27/88 C/L

The water collected in the french drain would then be conveyed to the Indianapolis sewerage system for final treatment.

Water from the ground water interception drain, the trench around the concrete pad and the vapor extraction system would be sampled and analyzed for the TCL parameters weekly, if possible, during the first 2 months after installation to determine the levels of contamination, if any, in the collected ground water. Afterwards, a monitoring program would be implemented according to the City of Indianapolis sewerage system requirements.

The ground water interception trench would be operated during the same time as the vapor extraction system. After that, the need for continued operation of the interception trench would be assessed based on the volume and quality of the water collected compared to the associated risk, if any, using the methodology in the Endangerment Assessment for the site as presented in the RI.

#### Performance Standards

- o prevent contamination, if any, attributable to the ECC site in the surface water south of the site; and
- o prevent contamination, if any, above endangerment levels in the sand and gravel unit beyond the interception trench.

## 6.0 ACCESS RESTRICTIONS

### Objectives

- o minimize contact with contaminated soils and water containing VOCs, semivolatile organics, and heavy metals; and
- o prevent further contaminant migration, if any, that could result from site excavation and development.

### Description

Access restrictions would consist of:

- o fencing around the site perimeter and posting of signs;
- o filing of appropriate restrictions with County registrar of deeds prohibiting usage of site for excavation and development;
- o filing of appropriate restrictions with County registrar of deeds prohibiting usage of ground water from the saturated till and the underlying sand and gravel; and
- o filing of appropriate restrictions with County registrar of deeds prohibiting installation of new water wells other than monitoring wells.

Ground water use restrictions would extend to areas where utilization of the shallow ground water would result in contamination, if any, being drawn to these locations.

Neither the saturated surface till nor the sand and gravel unit would predictably nor reliably support water supply development. Therefore, enforcing the restrictions on their use should not be difficult.

#### Performance Standards

- o the access restrictions to the site soils and ground water would be enforced by the appropriate County officials in accordance with prohibitions described above.

### 7.0 GROUND WATER AND SURFACE WATER MONITORING

#### Objectives

- o detect VOCs migration, if any, to the ground water and surface water; and
- o detect VOCs in the sand and gravel unit, if any, that are not captured by the ground water interception system in the surface till.

#### Description

The ground water monitoring network would consist of three (3) wells, which would be located downgradient of the southern limit of the ECC property and south of the Northside Sanitary Landfill (NSL) access road (Figure 1). These wells would be installed in



the sand and gravel unit underlying the saturated surface till. The wells would be 2-in PVC with an anticipated screen length less than or equal to 10 feet. If the sand and gravel unit intercepted by the boring is greater than 10 feet thick, the upper 10 feet would be screened. In cases where the sand and gravel is less than 10 feet thick, the entire sand and gravel interval would be screened.

The location of the monitoring wells is based on the ground water elevation contours shown in Figure 8. As part of the remediation of the NSL site, it has been proposed that the Unnamed Ditch be isolated in a concrete conduit. Without the Unnamed Ditch as a discharge zone, ground water flow beneath the eastern side of the ECC site will be southerly. Therefore, monitoring wells located south of the site (Figure 1) are appropriate.

Samples from these wells would be collected quarterly during site soil remediation and analyzed for the parameters in the Target Compound List (TCL). Once the soil remediation is completed, monitoring will be continued for three (3) years, on a semi-annual basis. Based on the distance to the monitoring wells, three (3) years will be sufficient time for any VOCs that escaped collection by vapor extraction to migrate from underneath the concrete pad to the wells in the sand and gravel unit (Table 3).

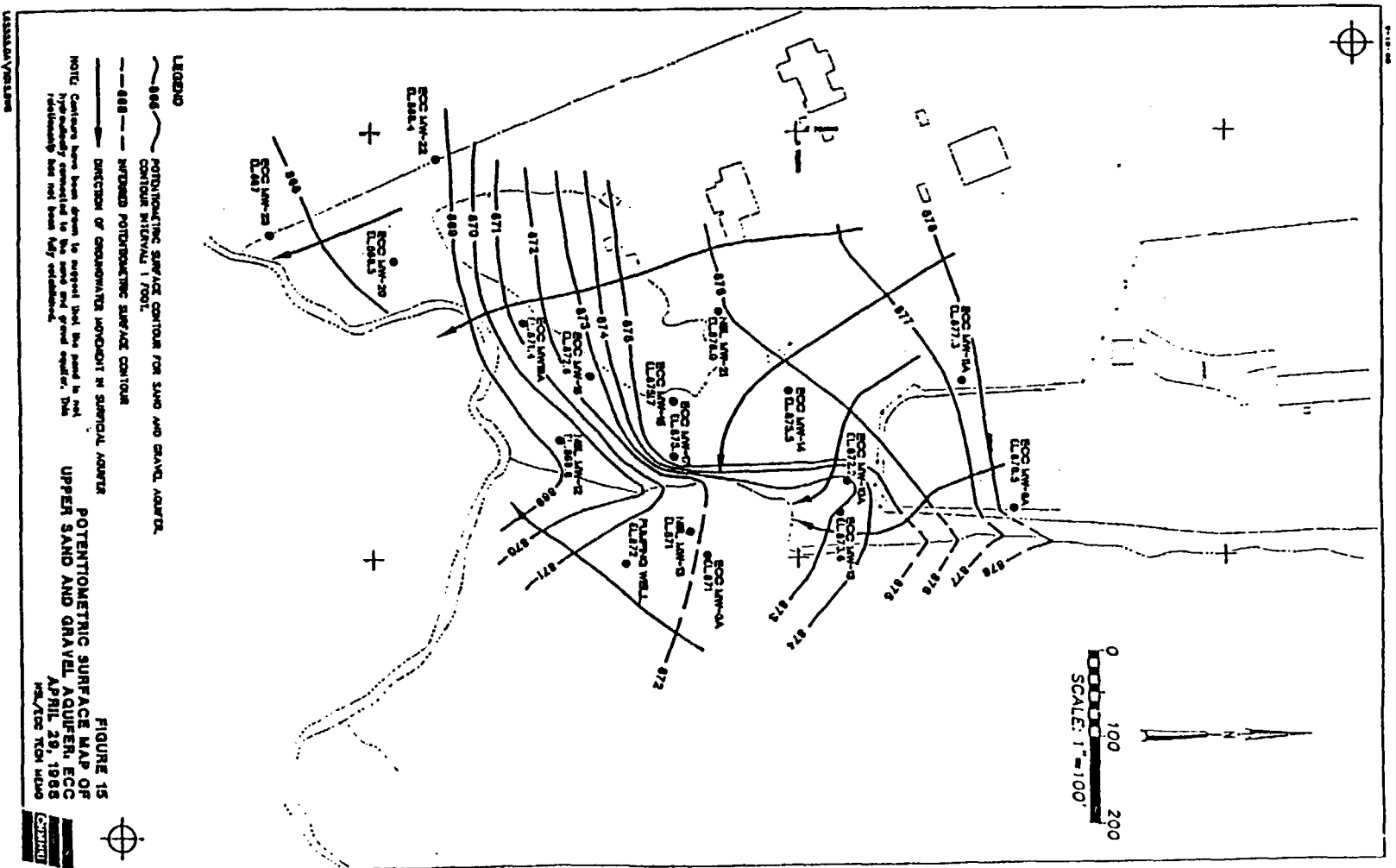
The indicator VOC of concern in the sand and gravel unit used for this analysis is trichloroethene (TCE). The travel time for this compound in this unit was estimated assuming a distance of 100 feet from the southern border of the concrete pad to the monitoring wells and permeabilities of  $10^{-3}$  -  $10^{-2}$  cm/sec. With the retardation factor calculated in Appendix C of the RI, the estimated time required for TCE to reach monitoring wells is 0.3-3 years (Table 3).

TABLE 3

ECC REMEDIAL ACTION PLAN  
CALCULATION OF TRAVEL TIME IN THE SAND AND GRAVEL UNIT  
BASED ON DATA AND METHODOLOGY IN THE ECC RI

<u>Parameter</u>	<u>TCE</u>
Retardation factor	3.2
Permeability of sand and gravel unit, cm/sec	$10^{-3} - 10^{-2}$
Ground water velocity, ft/yr	100 - 1,000
Distance to monitoring well from the concrete pad, ft	100
Travel time of compounds to monitoring well, yrs	0.3 - 3

(1) TCE = Trichloroethene



1500000-1000-1000

The surface water would be monitored by sampling the Unnamed Ditch just south of the NSL access road (Figure 1). Surface water would be sampled at the same frequency as ground water and analyzed for the same parameters.

The concentrations of TCE below which the monitoring would cease for the monitoring wells and the surface water sampling point are based on endangerment levels and the current historical data for the site. The threshold level of TCE for both the surface water sampling point and the monitoring wells would be 100 ug/l. The 100 ug/l level for the surface water sampling point is based on the concentration of TCE that would result in a  $6 \times 10^{-7}$  increased carcinogenic risk from wading in Finley Creek (Table E-14 of the RI). Using the same 100 ug/l value for the surface water sampling point and the monitoring wells is very conservative, since it assumes there is no dilution of surface water or ground water upon discharge to Finley Creek or Unnamed Ditch, respectively, in contrast to the 1:2 and 1:600 dilution ratios presented in Table 6-13 of the RI.

The monitoring would cease when the results for two (2) consecutive semi-annual sampling events, after the initial three (3) years of semi-annual sampling, are shown to be statistically significantly below these threshold values. Three (3) years is the longest calculated travel time to the monitoring point for the most significant indicator.

#### Performance Standards

- o monitoring wells should be operable at all times and inspected quarterly;
- o sampling should be conducted as specified;  
and

- o annual summary reports and an analysis of results from each sampling interval should be submitted to the USEPA.

## 8.0 SCHEDULE

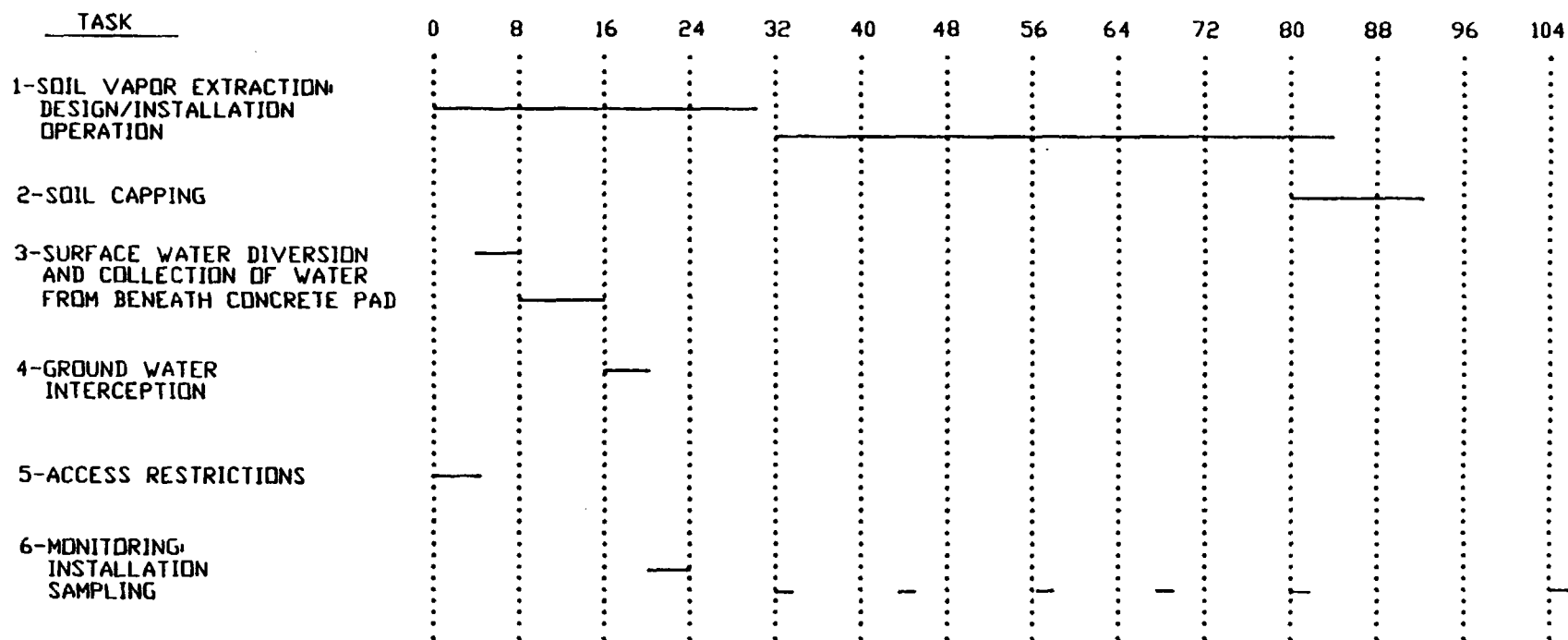
The estimated time required to complete design and implementation phases of the RAP is illustrated in Figure 9. This schedule is based on the number of weeks from a notice to proceed. Tasks to be conducted are:

- o soil vapor extraction:
  - 1) design/installation
  - 2) operation
- o soil capping
- o surface water diversion and collection of water from beneath the concrete pad
- o ground water interception
- o access restrictions
- o monitoring:
  - 1) installation
  - 2) sampling

Reports which will be prepared for USEPA review and comment are:

- o design document
- o monitoring well installation

**ESTIMATED PROJECT SCHEDULE**  
**ECC REMEDIAL ACTION WORK PLAN**  
**WEEKS FROM EFFECTIVE DATE OF PLAN APPROVAL**



\* SAMPLING WOULD BE CONDUCTED SEMIANNUALLY AFTER WEEK 104 FOR A MINIMUM OF 2.5 YEARS. SAMPLING AFTER THAT TIME WOULD BE AS DISCUSSED IN SECTION 7.0.

ERM	ECC SITE ESTIMATED PROJECT SCHEDULE		FIGURE 9
	ERM-North Central, Inc.		11/3/88
			CV

- o vapor extraction system installation
- o monthly progress reports during soil remediation
- o quarterly reports of results of analysis

**APPENDIX A**  
**TERRA VAC PILOT TEST**  
**AT**  
**ENVIRONMENTAL CHEMICAL AND CONSERVATION CORP.**  
**ZIONSVILLE, INDIANA**



TERRA VAC PILOT TEST  
AT  
ENVIRONMENTAL CHEMICAL AND CONSERVATION CORP.  
ZIONSVILLE, INDIANA

INTRODUCTION

This report discusses the results of the vapor extraction pilot test conducted by Terra Vac with ERM-North Central at the Environmental Chemical and Conservation Corporation (ECC) NPL site in Zionsville, Indiana. The report discusses the major project activities, data gathered, and significant findings in the following sections:

- I. Summary
- II. System Installation
- III. Vapor Extraction Operations
- IV. Analytical QA/QC
- V. Projection of Clean-Up Time

I. SUMMARY

The vapor extraction pilot test was successful in demonstrating the Terra Vac Process as a technically sound and cost effective method for removing volatile organics from the ECC site soils. Horizontal extraction wells were shown to be superior to vertical extraction wells for the site geology. Clean up time for the site using vapor extraction was estimated to be 300-400 days.

During Terra Vac's pilot test and operating period, approximately 548 pounds of VOCs were removed from the soil at the site. Tests show an approximate 20 foot radius of influence for horizontal

extraction wells. The extended run time on HEW-2 developed the data necessary to project clean up time. The vapor extraction operations began on June 13 and continued, with only minor shut downs, until July 20.

## II. SYSTEM INSTALLATION

During the week of June 1, Terra Vac personnel arrived on site to receive and procure materials for the job. Trenching began on June 7 and continued until June 8. Subsurface vapor monitoring wells and Vertical Extraction Well (VEW-1) were installed during the remainder of the week. Following extraction trench installation, the major components of the extraction system were manifolded together. Figure 1 is a drawing showing the layout of the test site.

During trench installation soil samples were taken and analyzed for VOCs using the headspace method. As expected, the VOC concentration was highly variable over the length of the trench. Table 1 is a summary of the chemical analyses of the soil samples.

## III. VAPOR EXTRACTION OPERATIONS

Appendix A is a daily summary of the system and the operation of each well. Appendix B contains operating and analytical data taken during the pilot test.

### A. Well Development

HEW-2 was initially developed for 22 hours. The results of the development period showed high VOC extraction rates and a radius of influence extending to approximately 15 feet. Following

development of HEW-2, vapor extraction from HEW-1 and VEW-1 was initiated as a combined development. The combined development continued for approximately four more days. The results of that development period indicated that HEW-1 had lower VOC extraction rates than HEW-2 but a comparable radius of influence. However, no significant radius of influence was measured from the vertical extraction well (VEW-1).

## B. Operations

Figure 2 is a plot of the Cumulative Pounds of VOC Extracted by the System versus Run Time. Approximately 548 pounds of VOC were removed from the soil at the site during Terra Vac's operations. After well development, operations focussed on HEW-2, where VOC concentrations were expected and found to be highest. HEW-2 remained in operation for a total of 31.4 days, with a total of 470.8 pounds of VOCs removed, as shown in Figure 3. The radius of influence stabilized at 15 to 20 feet.

Figure 4 and 5 show cumulative VOCs removed from HEW-1 and VEW-1. The short run times reflect both the slow development of VEW-1 and the decision to operate HEW-2 solely. Following development, the unexpectedly high flow rates from HEW-2 necessitated its solo operation so that the pilot system's effectiveness could be maximized.

Figure 6 shows HEW-2 VOC removal rates vs. run time. This type of curve is consistent with Terra Vac's previous experience. Early high rates decline to a relatively stable removal rate that slowly decreases (spikes before day 10 were caused by optimization procedures or short term shutdowns). Figure 7, showing initial and final rates for the major contaminants at HEW-2, indicates how these changes in VOC removal rate occur. There are substantial drops in rates from beginning to end for the more volatile components such as DCE, TCA, and TCE, while

rates for Toluene, PCE, and Xylenes have changed little or increased. The Total VOC Removal Rate dropped by 87% from its high point of 76 lb/day to a low point of 9.9 lb/day when the system was shut off.

The extracted VOCs were exhausted using a dispersion stack with agreement from the Indiana Department of Environmental Protection. Air quality testing was performed at the site boundary by ERM-North Central using a hand held vapor analyzer with a photoionization detector. At no time did concentrations of the indicator compounds at the site boundary exceed allowable limits.

#### IV. ANALYTICAL QA/QC

Several attachments (1-4) are included in this report that outline GC parameters, sampling and QC procedures. Vapor analyses were by direct injection of samples into a Shimadzu GC-9A gas chromatograph equipped with a flame ionization detector and utilizing a capillary column for separation of the compounds. Calibration checks or recalibrations were done daily, prior to sampling. All sample syringes were air purged via pump, with several blanks run to verify efficiency of purging procedure. Questionable results (i.e., an unusual change in concentration) was cause to run a syringe blank and resample to verify initial analysis.

#### V. PROJECTION OF CLEAN-UP TIME

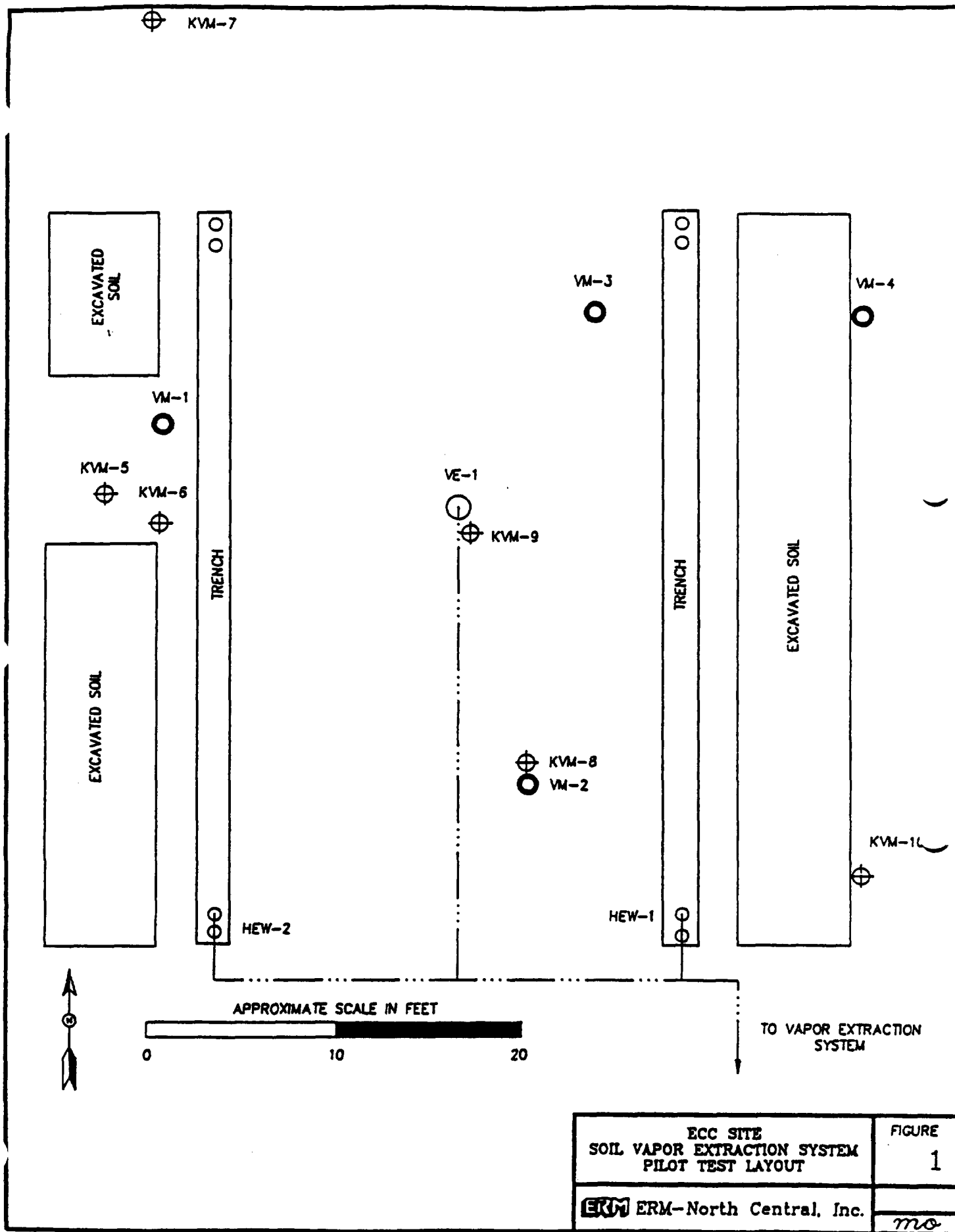
Based upon data collected from the operation of HEW-2, the clean-up time for the site using vapor extraction technology is projected to be approximately 350 days.

TABLE ONE

ECC SOILS DATA  
TERRA VAC PILOT TEST

HEW-1 SOIL SAMPLE ID	HEW-1 DEPTH FT.	HEW-1 DCE ppm	HEW-1 TCA ppm	HEW-1 BZ ppm	HEW-1 TCE ppm	HEW-1 TOL ppm	HEW-1 PCE ppm	HEW-1 mp-XYL ppm	HEW-1 TOTAL ppm
T1-3-3	3.0	.2	3.2	NA	7.7	1.9	4.5	1.9	19.4
T1-6-7	7.0	.4	2.4	NA	4.5	2.1	9.6	2.2	9.4
T1-6-9	9.0	.1	.0	NA	.0	.0	.1	.0	.2
T1-12-4	4.0	2.4	59.6	NA	99.7	5.1	187.5	2.3	166.7
T1-12-7	7.0	4.5	63.9	NA	125.0	5.9	155.2	2.2	199.3
T1-20-2	2.0	6.8	18.3	NA	59.0	10.6	2.4	2.9	94.5
T1-25-7	7.0	3.9	8.8	NA	24.5	4.0	11.5	1.7	41.1
T1-35-5	5.0	7.7	45.6	NA	7.9	4.6	4.0	1.8	65.7
T1-35-6	6.0	62.3	96.2	NA	49.7	9.4	103.1	3.8	217.6
T1-40-3	3.0	6.3	4.3	NA	2.0	.5	1.6	.2	13.1
T1-40-5	5.0	1.5	22.4	NA	2.6	1.0	1.1	.5	27.5
T1-40-7	7.0	.7	67.4	NA	9.0	6.9	1.9	.6	84.1

HEW-2 SOIL SAMPLE ID	HEW-2 DEPTH FT.	HEW-2 DCE ppm	HEW-2 TCA ppm	HEW-2 BZ ppm	HEW-2 TCE ppm	HEW-2 TOL ppm	HEW-2 PCE ppm	HEW-2 mp-XYL ppm	HEW-2 TOTAL ppm
T2-5-3	3.0	.6	3.6	NA	6.5	3.3	1.5	2.3	14.0
T2-5-7	7.0	1.1	180.8	NA	10.6	19.7	4.9	8.8	212.1
T2-5-9	9.0	.2	5.1	NA	8.5	1.2	8.7	1.0	15.0
T2-15-2	2.0	1.5	109.6	NA	6.8	15.3	2.1	3.4	133.2
T2-15-8	8.0	1.1	83.0	NA	16.2	13.8	2.2	4.9	114.1
T2-18-5	5.0	1.1	40.2	NA	12.0	.8	1.9	.1	54.2
T2-22-3	3.0	.4	54.7	NA	20.1	4.0	4.7	1.8	79.1
T2-22-8	8.0	.1	1.8	NA	.7	.4	.2	.2	3.0
T2-35-3	3.0	1.6	37.9	NA	58.7	18.1	26.4	10.1	116.2
T2-35-4	4.0	.6	54.5	NA	333.9	25.5	35.0	6.4	414.4
T2-35-7	7.0	1.4	68.9	NA	71.3	19.2	20.6	13.7	160.7
T2-43-5	5.0	2.5	153.5	NA	24.8	13.3	5.6	5.8	194.1
T2-45-2	2.0	.9	68.9	NA	21.7	12.5	3.8	4.1	103.9
T2-45-6	6.0	1.6	116.8	NA	15.4	14.1	2.5	4.6	147.8



<p>ECC SITE SOIL VAPOR EXTRACTION SYSTEM PILOT TEST LAYOUT</p>	<p>FIGURE 1</p>
<p>ERM North Central, Inc.</p>	<p>mo</p>

TOTAL LBS VOC REMOVED  
TERRA VAC - ECC PILOT TEST

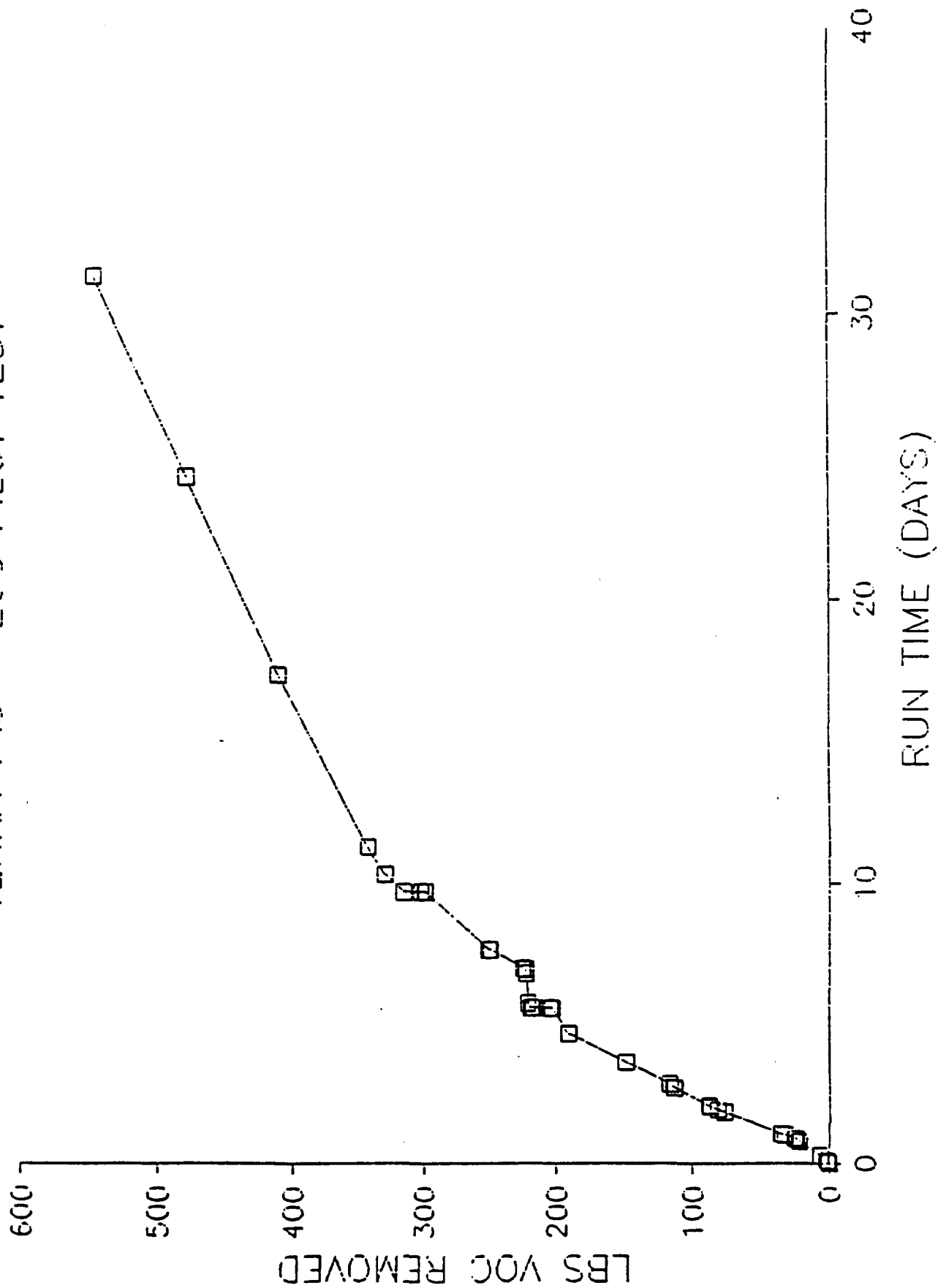


FIGURE 2

# HEW--2 LBS VOC REMOVED TERRA VAC HORIZONTAL EXTRACTION WELL

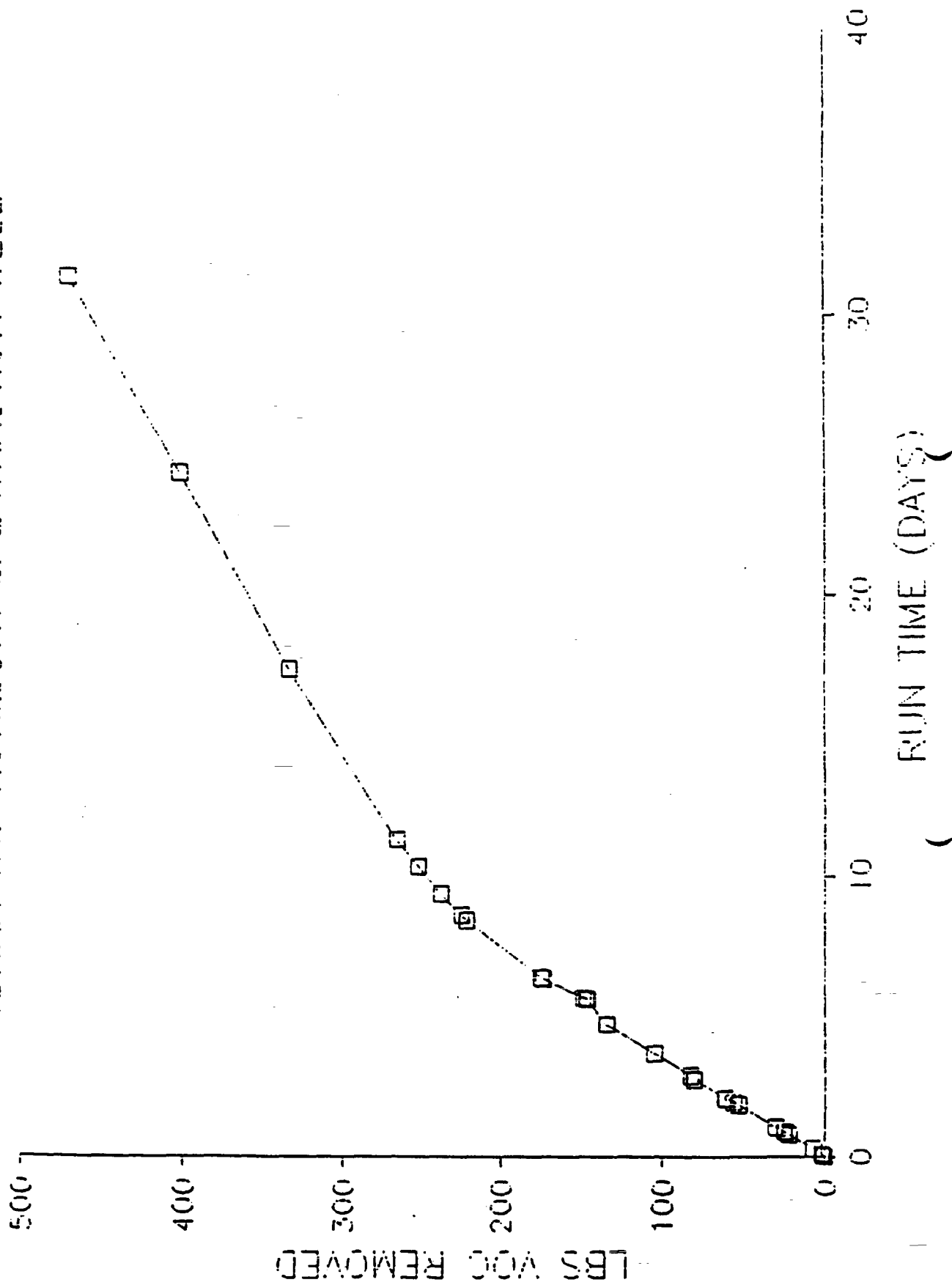


FIGURE 3



HEW--1 LBS VOC REMOVED  
TERRA VAC HORIZONTAL EXTRACTION WELL

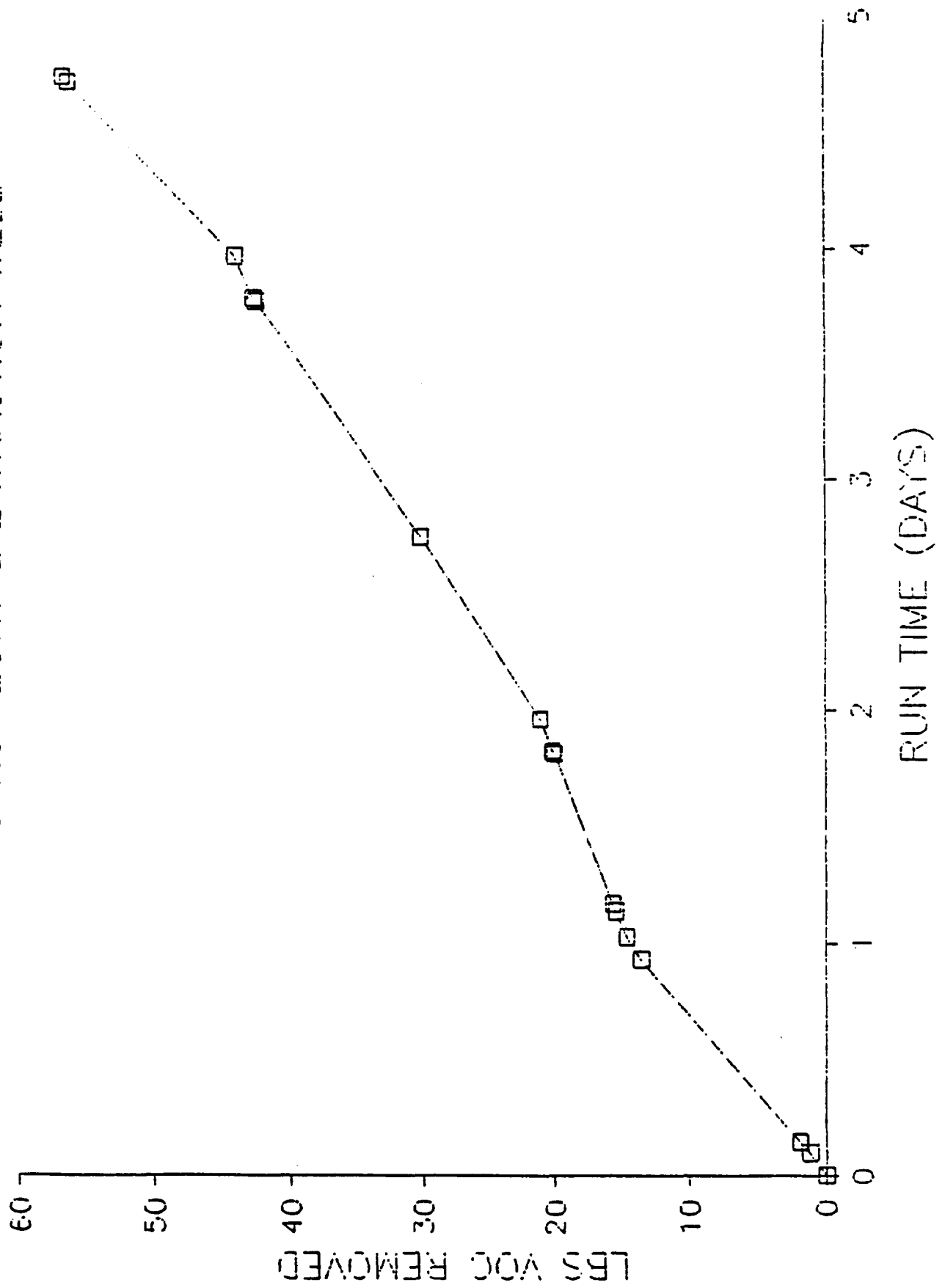


FIGURE 4

VEW-1 LBS VOC REMOVED  
TERRA VAC VERTICAL EXTRACTION WELL

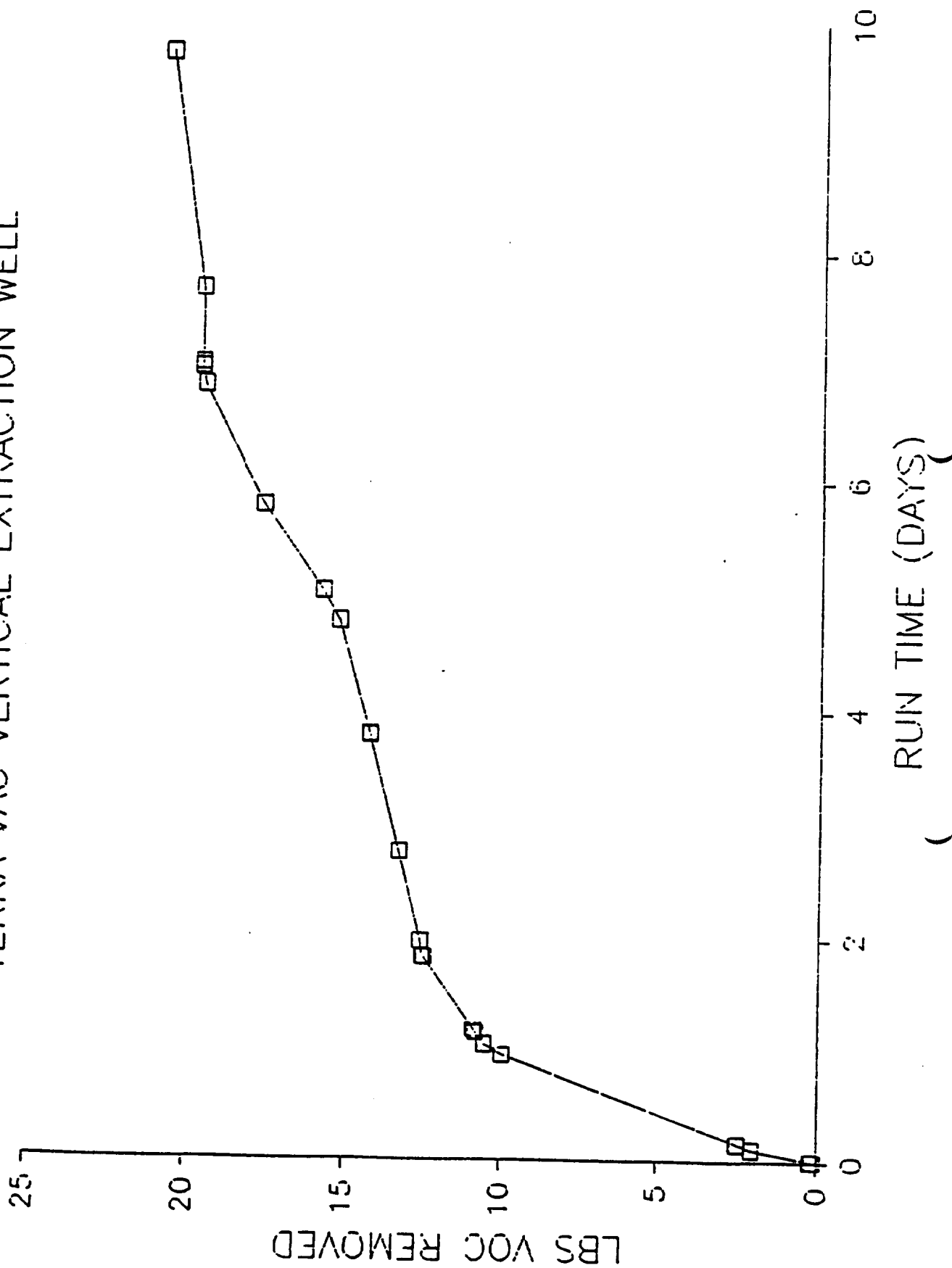


FIGURE 5

# HEW-2 VOC REMOVAL RATES TERRA VAC HORIZONTAL EXTRACTION WELL

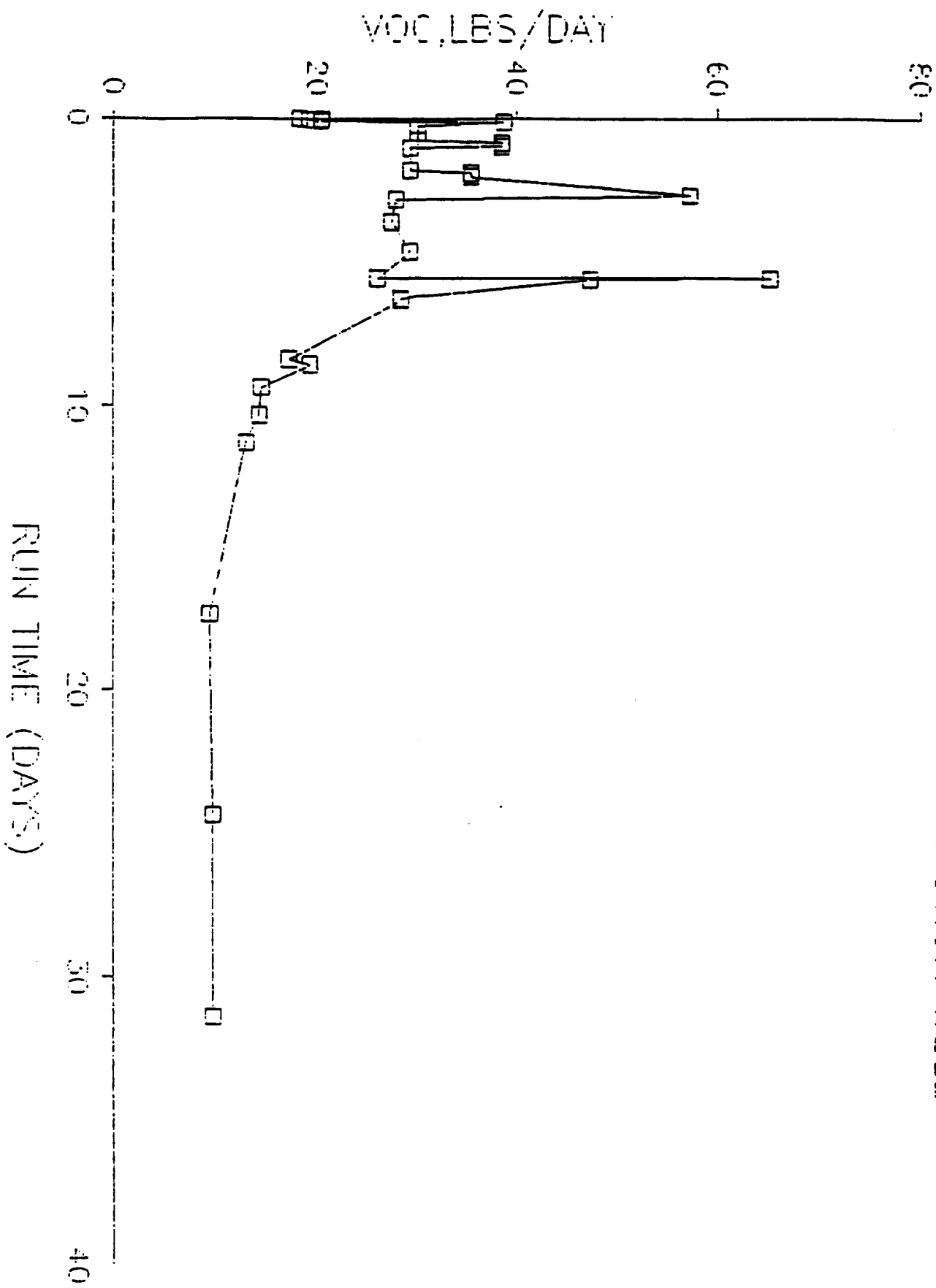


FIGURE 6

# HEW-2 INITIAL & FINAL RATES TERRA VAC HORIZONTAL EXTRACTION WELL

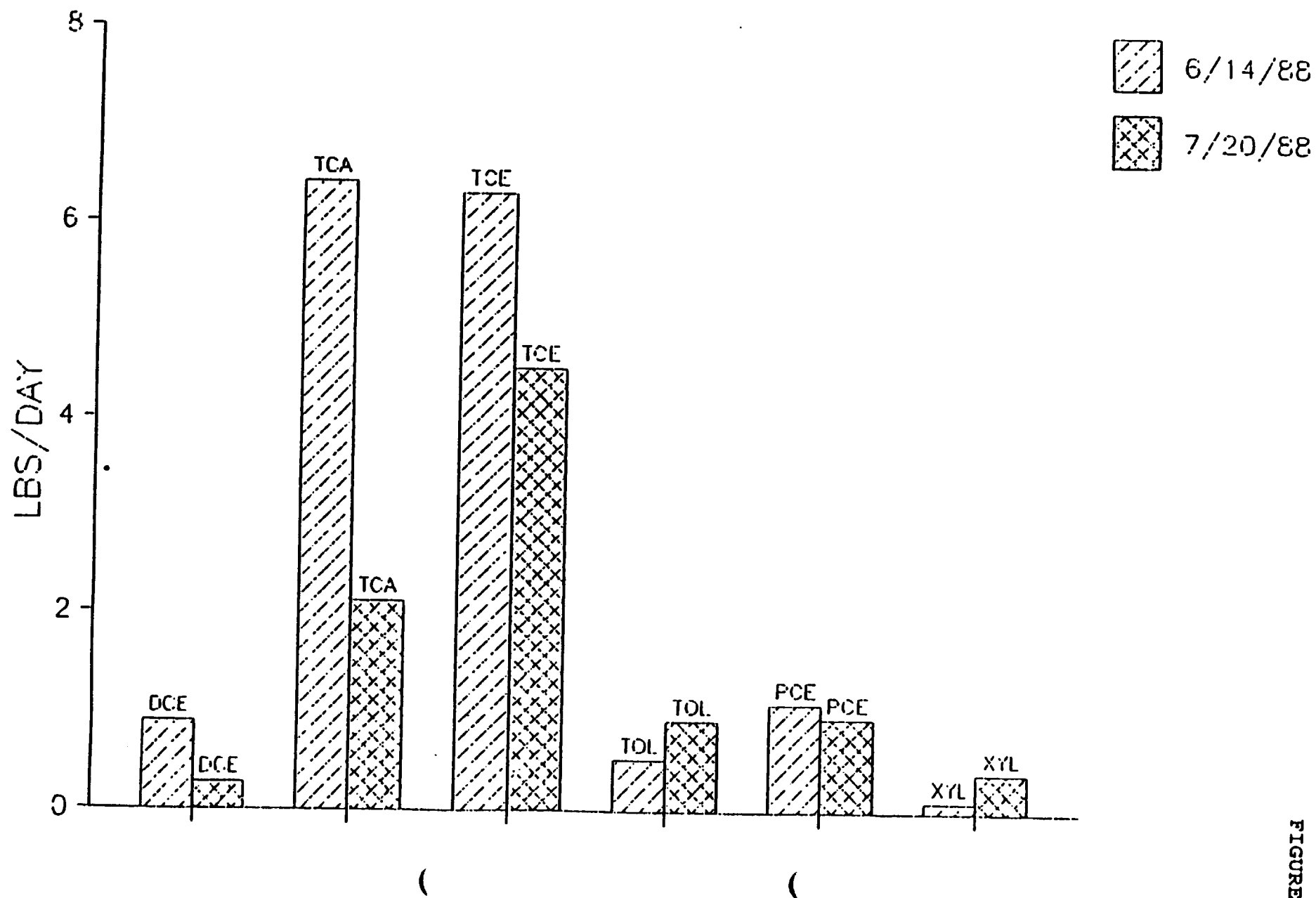


FIGURE 7

**APPENDIX A**

TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

XX													
XX SUMMARY - ECC VACUUM EXTRACTION PILOT TEST													
XX													
SAMPLE TIME		XX	X										
		XX	RUN X	FLOW	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUM
		XX	TIME X	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS MIN	XX	(DAYS)X	(SCFH)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17	XX	.00 X	0	0	0	0						0
14-Jun 12	18	XX	.00 X	4	.9	6.4	6.3	.5	1.1	.1	2.9	18.2	
14-Jun 12	38	XX	.01 X	4	.8	10.4	4.7	.7	.7	.1	3.0	20.5	
14-Jun 13	18	XX	.04 X	4	.9	10.3	4.3	.7	.9	.2	1.9	19.2	1
14-Jun 13	31	XX	.05 X	4									1
14-Jun 14	31	XX	.05 X	4									1
14-Jun 15	31	XX	.09 X	4	.7	11.5	4.7	.9	.9	.2	1.5	20.4	1
14-Jun 15	40	XX	.10 X	4									2
14-Jun 16	29	XX	.10 X	4									2
14-Jun 17	29	XX	.14 X	8	1.1	20.7	9.7	1.9	2.1	.6	2.7	38.7	2
14-Jun 20	42	XX	.28 X	8	.8	14.2	8.8	1.6	1.9	.5	2.1	30.1	7
15-Jun 8	39	XX	.77 X	17									22
15-Jun 9	20	XX	.77 X	17									22
15-Jun 11	30	XX	.86 X	17	1.0	15.5	13.4	2.2	3.0	.8	2.6	38.5	24
15-Jun 12	10	XX	.89 X	16								38.5	25
15-Jun 12	23	XX	.90 X	21	3.2	8.0	13.8	.3	1.4		.7	66.1	25
15-Jun 12	27	XX	.90 X	23	.8	2.9	1.5	.1	2.1		1.5	75.1	25
15-Jun 14	50	XX	1.00 X	38	1.3	9.4	5.3	1.0	4.1	.4	2.7	62.8	32
15-Jun 15	55	XX	1.05 X	41	.8	11.3	10.6	1.7	2.4	.5	2.1	53.6	35
15-Jun 16	2	XX	1.05 X	59								53.6	35
16-Jun 10	48	XX	1.83 X	79								53.6	77
16-Jun 13	6	XX	1.93 X	84	1.6	16.6	15.3	2.5	5.3	.8	3.4	45.5	82
16-Jun 15	45	XX	2.04 X	86								45.5	87
16-Jun 16	30	XX	2.07 X	98								45.5	88
16-Jun 19	15	XX	2.07 X	121									88
17-Jun 10	45	XX	2.72 X	191	2.9	23.5	24.4	3.2	8.6	1.0	12.3	75.9	113
17-Jun 11	0	XX	2.73 X	0	1.1	6.3	3.6	.5	3.4	1.0	12.3	75.9	114
17-Jun 11	40	XX	2.73 X	0									114
17-Jun 15	0	XX	2.87 X	202	.7	14.2	14.2	2.1	6.7	.6	3.4	41.9	116

A. 2.

[illegible]

TERRA VAC/ EOC - ERM SITE / PROJECT 88-304

XX HORIZONTAL EXTRACTION WELL - HEW-2															HEW-2
XXX OPERATING SUMMARY XXX															
SAMPLE TIME			XX	RUN TIME (DYS)	FLOW RATE (SCFM)	TOTAL VOC (mg/l)	DCE RATE (#/DY)	TCA RATE (#/DY)	TCE RATE (#/DY)	TOL RATE (#/DY)	PCE RATE (#/DY)	XYL RATE (#/DY)	OTHER RATE (#/DY)	T.VOC RATE (#/DY)	CUM VOC (LBS)
DATE	HRS	MIN	XX												
14-Jun 12	17	XX			0										0
14-Jun 12	18	XX			4	49.9	.9	6.4	6.3	.5	1.1	.1	2.9	18.2	
14-Jun 12	38	XX			4	55.9	.8	10.4	4.7	.7	.7	.1	3.0	20.5	.3
14-Jun 13	18	XX			4	52.5	.9	10.3	4.3	.7	.9	.2	1.9	19.2	.8
14-Jun 13	31	XX	.1		4							.2	1.9	19.2	1.0
14-Jun 14	31	XX	.1		4										1.0
14-Jun 15	31	XX	.1		4	52.5	.7	11.5	4.7	.9	.9	.2	1.5	20.4	1.4
14-Jun 15	40	XX	.1		4							.2	1.5	20.4	1.6
14-Jun 16	29	XX	.1		4										1.6
14-Jun 17	29	XX	.1		8	51.1	1.1	20.7	9.7	1.9	2.1	.6	2.7	38.7	2.4
14-Jun 20	42	XX	.3		8	40.1	.8	14.2	8.8	1.6	1.9	.5	2.1	30.1	7.0
15-Jun 8	39	XX	.8		17	51.1	1.1	20.7	9.7	1.9	2.1	.5	2.1	30.1	21.9
15-Jun 9	20	XX	.8		17										21.9
15-Jun 11	30	XX	.9		17	25.7	1.0	15.5	13.4	2.2	3.0	.8	2.6	38.5	23.7
15-Jun 12	10	XX	.9		16									38.5	24.7
15-Jun 12	23	XX	.9		16									38.5	25.1
15-Jun 12	27	XX	.9		17									38.5	25.2
15-Jun 14	50	XX	1.0		17									38.5	29.0
15-Jun 15	55	XX	1.0		17	19.8	.8	11.3	10.6	1.7	2.4	.5	2.1	29.3	30.6
15-Jun 16	2	XX	1.1		25									29.3	30.7
16-Jun 10	48	XX	1.8		33									29.3	53.6
16-Jun 13	6	XX	1.9		38	10.5	1.0	12.8	13.7	2.0	3.0	.6	2.3	35.4	56.7
16-Jun 15	45	XX	2.0		38									35.4	60.7
16-Jun 16	30	XX	2.1		44									35.4	61.8
16-Jun 19	15	XX	2.1		54										61.8
17-Jun 10	45	XX	2.7		106	6.0	1.8	17.2	20.8	2.7	5.3	.9	8.8	57.4	80.3
17-Jun 11	0	XX	2.7		0							.9	8.8	57.4	80.9
17-Jun 11	40	XX	2.7		0										80.9
17-Jun 15	0	XX	2.9		115	2.7		8.9	12.0	1.6	3.1	.4	1.9	27.9	82.8



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[illegible]

TERRA VAC/ ECC - ERH SITE / PROJECT 88-304

XX HORIZONTAL EXTRACTION WELL - HEW-1														HEW-1
XX														XX
SAMPLE TIME														XX
XXX OPERATING SUMMARY XXX														XXX
XX RUN FLOW TOTAL DCE TCA TCE TOL PCE XYL OTHER T.VOC CUH														XX
XX TIME RATE VOC RATE RATE RATE RATE RATE RATE RATE RATE RATE VOC														XX
DATE	HRS	MIN	XX	(DYS)	(SCFM)	(mg/l)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun	12	17	XX											
14-Jun	12	18	XX											
14-Jun	12	38	XX											
14-Jun	13	18	XX											
14-Jun	13	31	XX											
14-Jun	14	31	XX											
14-Jun	15	31	XX											
14-Jun	15	40	XX											
14-Jun	16	29	XX											
14-Jun	17	29	XX											
14-Jun	20	42	XX											
15-Jun	8	39	XX											
15-Jun	9	20	XX											
15-Jun	11	30	XX											
15-Jun	12	10	XX											
15-Jun	12	23	XX											.00
15-Jun	12	27	XX		2	58.74	.8	2.9	1.5	.1	2.1	1.47	8.9	
15-Jun	14	50	XX	.1	17	9.97	.9	5.2	2.3	.7	3.7	.3	1.70	14.8
15-Jun	15	55	XX	.1	17									1.2
15-Jun	16	2	XX	.2	25									1.9
16-Jun	10	48	XX	.9	33									1.9
16-Jun	10	48	XX	.9	33									1.9
16-Jun	13	6	XX	1.0	34	2.50	.5	2.8	1.2	.3	2.1	.1	.62	14.8
16-Jun	13	6	XX	1.0	34	2.50	.5	2.8	1.2	.3	2.1	.1	.62	13.5
16-Jun	15	45	XX	1.1	34									14.5
16-Jun	15	45	XX	1.1	34									15.4
16-Jun	16	30	XX	1.2	39									15.6
16-Jun	16	30	XX	1.2	39									15.6
16-Jun	19	15	XX	1.2	52									15.6
17-Jun	10	45	XX	1.8	68	2.23	.8	4.6	1.9	.3	3.0	.1	3.00	20.0
17-Jun	10	45	XX	1.8	68	2.23	.8	4.6	1.9	.3	3.0	.1	3.00	20.1
17-Jun	11	0	XX	1.8		2.23	.8	4.6	1.9	.3	3.0	.1	3.00	20.1
17-Jun	11	40	XX	1.8										20.1
17-Jun	15	0	XX	2.0	82	1.78	.7	4.9	2.0	.4	3.6	.2	1.44	21.0

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[illegible]

A 7

TERRA VAC/ ECC - ERH SITE / PROJECT 88-304

XX VERTICAL EXTRACTION WELL - VE-1													VE-1
XX													
SAMPLE TIME													
XXX OPERATING SUMMARY XXX													
XX RUN FLOW TOTAL DCE TCA TCE TOL PCE XYL OTHER T.VOC CUM													
XX TIME RATE VOC RATE RATE RATE RATE RATE RATE RATE RATE RATE VOC													
DATE	HRS	MIN	XX	(DYS)	(SCFH)	(mg/L)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17		XX										
14-Jun 12	18		XX										
14-Jun 12	38		XX										
14-Jun 13	18		XX										
14-Jun 13	31		XX										
14-Jun 14	31		XX										
14-Jun 15	31		XX										
14-Jun 15	40		XX										
14-Jun 16	29		XX										
14-Jun 17	29		XX										
14-Jun 20	42		XX										
15-Jun 8	39		XX										.00
15-Jun 9	20		XX										
15-Jun 11	30		XX										
15-Jun 12	10		XX										
15-Jun 12	23		XX		4	73.67	3.2	8.0	13.8	.3	1.4	.7	27.6 .1
15-Jun 12	27		XX		4								27.6 .2
15-Jun 14	50		XX	.1	4	25.36	.4	4.2	3.0	.4	.4	.1	1.0 9.5 2.0
15-Jun 15	55		XX	.2	8								9.5 2.5
15-Jun 16	2		XX	.2	8								9.5 2.5
16-Jun 10	48		XX	.9	13								9.5 10.0
16-Jun 13	6		XX	1.0	13	2.18	.1	1.0	.5	.3	.1	.5	2.5 10.5
16-Jun 15	45		XX	1.1	15								2.5 10.8
16-Jun 16	30		XX	1.2	15								2.5 10.9
16-Jun 19	15		XX	1.2	15								10.9
17-Jun 10	45		XX	1.8	17	3.31	.3	1.7	1.7	.3	.3	.1	.5 5.0 12.5
17-Jun 11	0		XX	1.8		3.31	.3	1.7	1.7	.3	.3	.1	.5 5.0 12.5
17-Jun 11	40		XX	1.8									12.5
17-Jun 15	0		XX	2.0	4	2.53	.1	.4	.2	.1		.1	.9 12.6

## TERRA VAC/ ECC - ERH SITE / PROJECT 88-304

[illegible]

**APPENDIX B**

TERIA FAC/ ECC - EEN SITE / PROJECT 88-304

II HORIZONTAL EXTRACTION WELL - REV-2																		REV-2																																			
II (( OPERATION DATA ))																		II (( GAS CHROMATOGRAPH READOUT ))																		II (( WELLEAD CONCENTRATION ))																	
SAMPLE TIME		II		INJ		WELL FLOW		FLOW		1.1		1.1.1		M.P.		TOTAL		1.1		1.1.1		M.P.																															
II		SAMP		VOL		VAC		RATE		RATE		DCE		TCA		TCE		TOL		PCE		ETL		AREA		DCE		TCA		TCE		TOL		PCE		ETL		OTHER															
DATE		HRS		MIN		II		NUM		(ml)		("Hg)		(SCFM)		(ACFM)		{(ng/li)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)		{(ng/l)															
14-Jun 12 17																		II 777																		0																	
14-Jun 12 18																		II 106																		100 10.0 4 5 II .163 1.170 1.150 .094 .200 .019 1020 II 2.445 17.55 17.25 1.420 3.000 .265 7.92																	
14-Jun 12 38																		II 107																		100 10.0 4 5 II .146 1.850 .863 .121 .109 .024 1105 II 2.190 28.35 12.95 1.815 1.955 .360 8.27																	
14-Jun 13 14																		II 108																		100 10.0 4 5 II .162 1.870 .791 .129 .132 .031 930 II 2.430 28.05 11.87 1.935 2.445 .465 5.31																	
14-Jun 13 31																		II 999																		100 10.0 4 5 II																	
14-Jun 14 31																		II 777																		100 10.0 4 5 II																	
14-Jun 15 31																		II 109																		100 7.5 4 5 II .128 2.216 .903 .171 .131 .048 990 II 1.707 29.55 12.04 2.250 2.387 .640 3.94																	
14-Jun 15 40																		II 999																		100 8.0 4 5 II																	
14-Jun 16 29																		II 777																		100 9.0 4 5 II																	
14-Jun 17 25																		II 110																		100 8.5 8 10 II .103 1.953 .915 .182 .138 .057 928 II 1.437 27.25 12.77 2.540 2.721 .795 3.55																	
14-Jun 20 42																		II 111																		100 9.0 6 10 II .077 1.338 .823 .152 .130 .051 728 II 1.100 18.97 11.76 2.171 2.586 .729 2.78																	
15-Jun 8 39																		II 999																		100 9.3 17 20 II																	
15-Jun 9 20																		II 777																		100 9.0 17 20 II																	
15-Jun 11 30																		II 112																		100 9.0 17 20 II .046 .724 .626 .104 .104 .036 475 II .657 10.34 8.94 1.486 2.000 .514 1.76																	
15-Jun 12 10																		II 888																		100 10.0 16 20 II																	
15-Jun 12 23																		II 888																		100 10.0 16 20 II																	
15-Jun 12 27																		II 888																		100 9.0 17 20 II																	
15-Jun 14 50																		II 888																		100 8.5 17 20 II																	
15-Jun 15 55																		II 117																		100 9.5 17 20 II .036 .520 .491 .077 .084 .025 358 II .527 7.610 7.165 1.127 1.595 .366 1.39																	
15-Jun 16 2																		II 888																		100 8.5 25 30 II																	
16-Jun 10 48																		II 888																		100 9.0 33 40 II																	
16-Jun 13 6																		II 130																		100 9.1 38 45 II .020 .266 .283 .042 .051 .012 191 II .287 3.816 4.062 .603 .904 .172 .68																	
16-Jun 15 45																		II 888																		100 9.0 38 45 II																	
16-Jun 16 30																		II 999																		100 1.0 44 45 II																	
16-Jun 19 15																		II 777																		100 12.0 54 70 II																	
17-Jun 10 45																		II 125																		100 7.8 106 123 II .014 .134 .162 .021 .034 .007 143 II .189 1.811 2.189 .264 .554 .095 .93																	
17-Jun 11 0																		II 999																		100 1.0 0 II																	
17-Jun 11 40																		II 777																		100 1.0 0 II																	
17-Jun 15 0																		II 129																		100 9.0 115 138 II ND .060 .081 .011 .018 .003 50 II .857 1.157 .157 .300 .043 .10																	

[illegible]

Year	Month	Day	Time	Location	Event	Result	Score	Rank	Notes
2020	Jan	5	10:00	XX	955	100	1.0	0	
2020	Jan	10	10:00	XX	955	100	1.0	0	
2020	Jan	15	10:00	XX	955	100	1.0	0	
2020	Jan	20	10:00	XX	955	100	1.0	0	
2020	Jan	25	10:00	XX	955	100	1.0	0	
2020	Jan	30	10:00	XX	955	100	1.0	0	
2020	Jan	31	10:00	XX	955	100	1.0	0	
2020	Feb	1	10:00	XX	955	100	1.0	0	
2020	Feb	2	10:00	XX	955	100	1.0	0	
2020	Feb	3	10:00	XX	955	100	1.0	0	
2020	Feb	4	10:00	XX	955	100	1.0	0	
2020	Feb	5	10:00	XX	955	100	1.0	0	
2020	Feb	6	10:00	XX	955	100	1.0	0	
2020	Feb	7	10:00	XX	955	100	1.0	0	
2020	Feb	8	10:00	XX	955	100	1.0	0	
2020	Feb	9	10:00	XX	955	100	1.0	0	
2020	Feb	10	10:00	XX	955	100	1.0	0	
2020	Feb	11	10:00	XX	955	100	1.0	0	
2020	Feb	12	10:00	XX	955	100	1.0	0	
2020	Feb	13	10:00	XX	955	100	1.0	0	
2020	Feb	14	10:00	XX	955	100	1.0	0	
2020	Feb	15	10:00	XX	955	100	1.0	0	
2020	Feb	16	10:00	XX	955	100	1.0	0	
2020	Feb	17	10:00	XX	955	100	1.0	0	
2020	Feb	18	10:00	XX	955	100	1.0	0	
2020	Feb	19	10:00	XX	955	100	1.0	0	
2020	Feb	20	10:00	XX	955	100	1.0	0	
2020	Feb	21	10:00	XX	955	100	1.0	0	
2020	Feb	22	10:00	XX	955	100	1.0	0	
2020	Feb	23	10:00	XX	955	100	1.0	0	
2020	Feb	24	10:00	XX	955	100	1.0	0	
2020	Feb	25	10:00	XX	955	100	1.0	0	
2020	Feb	26	10:00	XX	955	100	1.0	0	
2020	Feb	27	10:00	XX	955	100	1.0	0	
2020	Feb	28	10:00	XX	955	100	1.0	0	
2020	Feb	29	10:00	XX	955	100	1.0	0	
2020	Feb	30	10:00	XX	955	100	1.0	0	
2020	Feb	31	10:00	XX	955	100	1.0	0	
2020	Mar	1	10:00	XX	955	100	1.0	0	
2020	Mar	2	10:00	XX	955	100	1.0	0	
2020	Mar	3	10:00	XX	955	100	1.0	0	
2020	Mar	4	10:00	XX	955	100	1.0	0	
2020	Mar	5	10:00	XX	955	100	1.0	0	
2020	Mar	6	10:00	XX	955	100	1.0	0	
2020	Mar	7	10:00	XX	955	100	1.0	0	
2020									



VERBA FAC/ ECC - ERM SITE / PROJECT 88-304

		II HORIZONTAL EXTRACTION WELL - EET-1																EET-1		EET-1	
		II																			
SAMPLE TIME	II	(( OPERATION DATA ))				(( GAS CHROMATOGRAPH READOUT ))								(( WELLEHEAD CONCENTRATION ))							
	II	INJ	WELL FLOW	FLOW	II	1.1	1.1.1	M.F- TOTAL				II	1.1	1.1.1	M.F-						
	II	SUMP VOL	VAC RATE	RATE	II	BCE	TCL	TCE	TOL	PCE	XYL	AREA	II	BCE	TCL	TCE	TOL	PCE	XYL	OTHER	
DATE	HRS MIN	II	NUM	(ml)	(°g)	(SCFM)	(ACFM)	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	1000X	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	
=====																					
14-Jun 12	17	II																			
14-Jun 12	18	II	100	1.0																	
14-Jun 12	38	II	100	1.0																	
14-Jun 13	18	II	100	1.0																	
14-Jun 13	31	II	100	1.0																	
14-Jun 14	31	II	100	1.0																	
14-Jun 15	31	II	100	1.0																	
14-Jun 15	40	II	100	1.0																	
14-Jun 16	29	II	100	1.0																	
14-Jun 17	29	II	100	1.0																	
14-Jun 20	42	II	100	1.0																	
15-Jun 8	39	II	100	1.0																	
15-Jun 9	20	II	100	1.0																	
15-Jun 11	30	II	100	1.0																	
15-Jun 12	10	II	100	1.0																	
15-Jun 12	23	II	777	100	1.0																
15-Jun 12	27	II	114	100	8.5	2	2	.377	1.360	.701	.034	1.015	.008	1210	.526	19.26	9.76	.47	14.16	.11	9.70
15-Jun 14	50	II	115	100	9.5	17	20	.040	.241	.107	.030	.170	.015	194	.59	3.53	1.57	.44	2.49	.32	1.15
15-Jun 15	55	II	668	100	9.5	17	20														
15-Jun 16	2	II	888	100	9.5	25	30														
16-Jun 10	48	II	668	100	9.5	33	40														
16-Jun 13	6	II	122	100	8.8	34	40	.012	.065	.027	.006	.049	.003	44	.17	.92	.38	.08	.69	.04	.20
16-Jun 15	45	II	668	100	8.8	34	40														
16-Jun 16	30	II	999	100	1.0	39	40														
16-Jun 19	15	II	777	100	1.0	52	53														
17-Jun 10	45	II	124	100	8.4	66	80	.009	.054	.022	.003	.036	.001	54	.13	.75	.31	.04	.56	.01	.49
17-Jun 11	6	II	999	100	1.0																
17-Jun 11	40	II	777	100	1.0																
17-Jun 15	0	II	127	500	9.7	82	100	.031	.227	.090	.018	.163	.007	158	.69	.67	.27	.05	.48	.02	.20

TEHERA FAC/ ECC - ERM SITE / PROJECT 88-304

		II		II HORIZONTAL EXTRACTION WELL - EET-1														EET-1		EET-1			
		II		II (( OPERATION DATA ))						II (( GAS CHROMATOGRAPH READOUT ))						II (( WELLHEAD CONCENTRATION ))							
		II		II INJ WELL FLOW		II FLOW		II 1.1		II 1.1.1		II N.P- TOTAL		II 1.1		II 1.1.1		II N.P-					
		II		II SAMP VOL		II VIC RATE		II RATE		II BCE		II PCA		II TCE		II TOL		II PCE		II ITL		II OTHER	
DATE	RES MIN	II	NUM	(ml)	(°Eq)	(SCFH)	(ACFH)	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	1000X	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))
18-Jun 10	0	II	151	500	7.2	90	163	II	.022	.152	.085	.013	.130	.005	102	II	.06	.51	.22	.03	.34	.01	.06
19-Jun 10	30	II	134	500	6.8	114	130	II	.014	.187	.090	.012	.147	.004	152	II	.04	.48	.23	.03	.38	.01	.22
19-Jun 10	47	II	599	100	1.0			II								II							
19-Jun 11	40	II		100	1.0			II								II							
20-Jun 9	20	II		100	1.0			II								II							
20-Jun 9	50	II		100	1.0			II								II							
20-Jun 10	35	II	777	100	1.0			II								II							
20-Jun 15	0	II	138	500	9.5	141	176	II	.015	.161	.074	.011	.133	.004	78	II	.04	.47	.22	.03	.35	.01	.04
21-Jun 9	0	II	139	1000	7.4	145	215	II	.020	.291	.138	.023	.255	.009	179	II	.03	.39	.19	.03	.34	.01	.08
21-Jun 9	33	II	599	100	1.0			II								II							
21-Jun 10	30	II		100	1.0			II								II							
22-Jun 10	0	II		100	1.0			II								II							
22-Jun 16	10	II		100	1.0			II								II							
23-Jun 10	0	II		100	1.0			II								II							
24-Jun 11	0	II		100	1.0			II								II							
24-Jun 14	30	II		100	1.0			II								II							
24-Jun 16	34	II		100	1.0			II								II							
24-Jun 16	50	II		100	1.0			II								II							
24-Jun 17	35	II		100	1.0			II								II							
25-Jun 9	15	II		100	1.0			II								II							
25-Jun 10	30	II		100	1.0			II								II							
27-Jun 11	30	II		100	1.0			II								II							
27-Jun 11	45	II		100	1.0			II								II							
27-Jun 16	0	II		100	1.0			II								II							
28-Jun 10	35	II		100	1.0			II								II							
29-Jun 10	0	II		100	1.0			II								II							
30-Jun 9	15	II		100	1.0			II								II							
06-Jul 11	0	II		100	1.0			II								II							
13-Jul 11	0	II		100	1.0			II								II							
20-Jul 10	40	II		100	1.0			II								II							

6:

II VERTICAL EXTRACTION WELL - VE-1												VERTICAL EXTRACTION WELL - VE-1											
II												II											
II (( OPERATION DATA )) II												II (( GAS CHROMATOGRAPH READOUT )) II											
II												II											
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II												II N,P-											
II SAMP VOL VAC RATE RATE II DCE TCA TCE TOL PCE XFL AREA II DCE TCA TCE TOL PCE XFL CYCLE												II											
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14-Jun 12 36 II 100 1.0 II 0 II																							
14-Jun 13 16 II 100 1.0 II 0 II																							
14-Jun 13 31 II 100 1.0 II 0 II																							
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14-Jun 20 42 II 100 1.0 II 0 II																							
15-Jun 8 39 II 100 1.0 II 0 II																							
15-Jun 9 20 II 100 1.0 II 0 II																							
15-Jun 11 30 II 100 1.0 II 0 II																							
15-Jun 12 10 II 777 100 8.8 II 0 II																							
15-Jun 12 23 II 113 100 9.0 4 5:1 .606 1.501 2.584 .059 .267 .007 1049 II 8.657 21.44 36.91 .843 3.814 .100 1.25																							
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15-Jun 15 45 II 888 100 1.0 15 15:1 II																							
15-Jun 16 30 II 999 100 1.0 15 15:1 II																							
15-Jun 19 15 II 777 100 1.0 15 15:1 II																							
17-Jun 10 45 II 126 100 8.8 17 20:1 .016 .081 .082 .012 .015 .003 68 II .226 1.15 1.16 .170 .212 .042 .36																							
17-Jun 11 0 II 999 100 1.0 II																							
17-Jun 11 40 II 777 100 1.0 II																							
17-Jun 15 0 II 128 500 10.0 4 5:1 .653 .339 .213 .070 .041 .017 280 II .159 1.02 .64 .210 .123 .051 .33																							

—

**ATTACHMENT 1**

## TERRA VAC CORPORATION

Project 88-304

Gas Chromatograph ParametersI. SCOPE

In order to accurately quantitate Volatile Organic Compound (VOC) content it is necessary to insure peak separation. This is achieved by the use of an appropriate column, with the aid of a temperature program. The parameters for this program are set forth here.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Temperature programmable gas chromatograph (Shimadzu GC-9A) equipped with a flame ionization detector (FID) and a wide bore capillary column.
3. Nitrogen, carrier gas, zero grade or better
4. Hydrogen, combustion gas, zero grade or better
5. Air, combustion gas, zero grade or better

III. PARAMETERS

1. Initial temperature, 40 C
2. Initial hold, 2 minutes
3. Program rate, 5 C/minute
4. Intermediate temperature, 85 C
5. Intermediate hold, 0.5 minutes
6. Secondary ramp rate, 15 C/minute
7. Final temperature, 150 C
8. Final hold, 3 minutes
9. Inlet temperature, 150 C
10. Carrier gas flow, 20 ml/minute
11. Combustion gas flow, Air, 350 ml/minute
12. Combustion gas flow, Hydrogen, 55 ml/minute
13. Detector range, 10<sup>-1</sup>

IV. PRECAUTIONS

Do not exceed temperature limit of column. Do not operate oven without oven fan operating. Periodically check and clean air filter to electronics. Technician must be fully trained before attempting to operate the gas chromatograph.

**ATTACHMENT 2**



## TERRA VAC CORPORATION

Project 88-304

Integrator ParametersI. SCOPE

The parameters stated here are normal operating parameters for use with a flame ionization detector (FID). These parameters will require periodic optimization by the operator in order to achieve maximum sensitivity.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Integrator (Shimadzu C-R3A)

III. PARAMETERS

1. Zero = 0
2. Attenuation (ATTN 2 ) = 4
3. Chart speed (CHT SP) = 10 mm/min.
4. Area reject (AR REJ) = 250
5. Slope = 300

IV. PRECAUTIONS

It is important that the operator has a full understanding of the instrument in order to achieve optimization. If in doubt about any procedure, refer to the operation manual.

**ATTACHMENT 3**

TERRA VAC CORPORATION

Project 88-304

Sampling Techniques of Volatile Organic Compounds

I. SCOPE

Volatile Organic Compounds (VOC) are regulated, toxic chemicals and should be treated with care to avoid personal and environmental contamination.

When sampling vapors from the vacuum system it will be considered that the air stream is contaminated with VOC's.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Hamilton Gastight Syringes 1000ul, 500ul, 250ul sizes

III. PROCEDURE

1. Purge syringe with clean air
2. Insert syringe into well head septum
3. Purge syringe with air stream to be sampled
4. Draw plunger back to desired volume
5. Withdraw needle from wellhead septum and stopper with a septum
6. Log time, location, wellhead vacuum and flow then return sample to GC

IV. PRECAUTIONS

Test syringe before use for leaking plunger and tight needle.

**ATTACHMENT 4**

## TERRA VAC CORPORATION

Project 88-304

Volatile Organic Compounds StandardI. SCOPE

The purpose of this procedure is to define the standardization of the gas chromatograph for reference in the quantitative analysis of samples containing unknown amounts of Volatile Organic Compounds.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Gastight syringes 1000ul, 250ul, 100ul.
3. Pure compounds (CAUTION: Some VOC's are known carcinogens and should be handled with care to avoid possible contamination.)
4. Gas sampling bulb 1000ml size

III. PROCEDURESCalibration using pure VOC to make gas standard

1. Run a blank of the syringe and 1 liter gas sampling bulb to be used.
2. Inject a known volume of the liquid VOC (or of an equal volume mixture of several compounds of interest) into the 1 liter bulb (verify actual bulb volume beforehand). This is on the order of 1 ul for 100 to 300 ppm levels.
3. Allow the liquid to vaporize and disperse throughout the bulb. This may take 5-10 minutes depending on volatility of the compounds. See precautions.
4. Using a gastight syringe, withdraw a 100-1000ul sample from the bulb and inject it into the GC. Volume utilized should approximate expected field concentrations.
5. Calculation of concentration:

$$\text{mg/L} = \frac{\text{sp.gravity} * \text{liq.vol} * \% \text{purity} * \text{inj.volume (ul)}}{\text{bulb volume} * 100\% * 1000\text{ul}}$$

6. If not within 10% of previous calibration, repeat 4&5. Otherwise maintain calibration values established.
7. Calibrate to new values when repeatability is shown. See precautions.

#### IV PRECAUTIONS

1. In injecting headspace vapor from pure compound, care must be taken not to overload the column.
2. A wide change in calibration values indicates that troubleshooting of the system or procedures is necessary.
3. In using a liquid, be sure the volume injected will be well below vapor saturation for the bulb volume used.
4. Examine the bulb for any droplets or condensation that may indicate incomplete vaporization of the liquid. Some warming of the bulb (i.e., sunlight, rubbing with a cloth, even the GC oven briefly) may hasten the process. The less volatile the compound, the more problem this becomes.
5. Do not rely on the bulb's integrity for more than an hour.

**APPENDIX B**

**ECC REMEDIAL ACTION PLAN  
ESTIMATION OF WATER VOLUMES COLLECTED  
IN THE GROUND WATER INTERCEPTION TRENCH**

## APPENDIX B

### ECC REMEDIAL ACTION PLAN ESTIMATION OF WATER VOLUMES COLLECTED IN THE GROUND WATER INTERCEPTION TRENCH

Following the procedure in Appendix B of the FS:

$$Q_t = Q_r + Q_i + Q_{rec}$$

where:

$Q_t$  = total water flow to the trench, gpm

$Q_r$  = regional ground water flow to the trench, gpm

$Q_i$  = flow induced due to the presence of the trench, gpm

$Q_{rec}$  = recharge flow, due to precipitation and upward recharge from the sand and gravel unit, gpm

$$Q_r = K_r \cdot A_r \cdot i_r$$

where:

$K_r$  = permeability of till =  $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup> (section 5 of RI)

$d$  = depth of trench, assume 10 ft

$A_r$  = area of trench in the direction of ground water flow, ft<sup>2</sup> =  $L \times d$

$L$  = length of trench, 330 ft

$i_r$  = regional gradient = 0.05 ft/ft south of the site (Appendix B of FS)

$$Q_i = K_i \cdot i_I \cdot A_i$$

where:

$K_i$  = permeability of till =  $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup> (Section 5 of RI)



$i_i$  = gradient induced due to drain -  $h/l$

$h$  = height of water table above the drain centers  
=  $1/2$  maximum depth = 5 ft

$l$  =  $z/2$  = 20 ft

$z$  = zone of influence of trench in the perpendicular direction, 40 ft

$A_i$  = area of induced flow =  $L \times h$

$$Q_{rec} = (W_p + W_v) A_{rec}$$

where:

$W_p$  = recharge due to precipitation, assumed to be  
7.8 in/yr = 0.013 gal/d.ft<sup>2</sup> (Appendix B of FS)

$W_v$  = recharge due to upward movement from the sand and gravel unit =  $k_v \times i_v$

$k_v$  = vertical permeability of till assumed to be  
 $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup>

$i_v$  = vertical gradient = 0.25 ft/ft = 3 ft difference in head over 12 ft of thickness of shallow saturated zone (Appendix B of FS)

$A_{rec}$  = recharge area, ft<sup>2</sup> -  $L \times Z$

For the trench to be installed at ECC =

$$\begin{aligned} Q_r &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 10 \text{ ft} \times 0.05 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.03 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_i &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 5 \text{ ft} \times 0.25 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.06 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_{rec} &= 0.013 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 1 \text{ d/1440 min} \\ &\quad + 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 0.25 \text{ ft/ft} \times 1 \text{ d/1440 min} \\ &= 0.61 \text{ gpm} \end{aligned}$$

$$Q_t = 0.03 + 0.06 + 0.61 = 0.70 \text{ gpm}$$



**ERM-North Central, Inc.**

**Environmental Resources Management**

102 Wilmot Road • Suite 300 • Deerfield, Illinois 60015 ☎ (312) 940-7200

December 7, 1988

Karen Vendl  
U.S. Environmental Protection Agency  
Region V (5HE-12)  
230 South Dearborn Street  
Chicago, Illinois 60604

Re: ECC Remedial Action

Dear Ms. Vendl:

As instructed by the ECC Settlers Steering Committee, enclosed please find, for your review and comments, five (5) copies of the revised first two sections of Exhibit A to the Consent Decree for remediation of the Environmental Conservation and Chemical Corporation (ECC) site at Zionsville, Indiana.

Section 3, the complete design, will be provided in the near future and will include the following items:

- o Project Description;
- o Engineering Calculations;
- o Identification of Construction/Operation permits and requirements;
- o Detailed engineering specifications and drawings of:
  - Building and foundation
  - Electrical
  - Mechanical
  - Piping and instrumentation
  - Site plans with details
  - Demolition

**ERM-North Central, Inc.**

Karen Vendl

Page 2

December 7, 1988

- o Health and Safety Plan;
- o Quality Assurance Project Plan;
- o Operation and Maintenance Plan;
- o Final Construction Schedule

Please do not hesitate to call if you have any comments.

Very truly yours,

ERM-NORTH CENTRAL, INC.

*Roy Ball / EFM*

Roy O. Ball, Ph.D., P.E.  
Principal

rms  
enclosures

cc: D. Smith, Pratt & Lambert  
J. Amber, Ford Motor Company  
N. Bernstein, Jenner & Block  
T. Harker, The Harker Firm  
J. Kyle, Barnes & Thornburg  
K. Johnson, Metal Working Lubricants

**EXHIBIT A**

**ENVIRONMENTAL CONSERVATION AND  
CHEMICAL CORPORATION (ECC) SITE  
ZIONSVILLE, INDIANA**

**DECEMBER, 1988**

**PREPARED FOR:**

**ECC SETTLERS STEERING COMMITTEE**

**PREPARED BY:**

**ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, ILLINOIS 60015**

**PROJECT NO. 8076**

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## **SECTION 1.0**

### **INTRODUCTION**

This is a description of the alternative Remedial Action Plan (RAP) proposed by the Environmental Conservation and Chemical Corporation (ECC) Settlers Steering Committee in response to the September, 1987 Record of Decision (ROD) issued for the ECC site by the U.S. Environmental Protection Agency (EPA).

## SECTION 2.0

### ALTERNATIVE REMEDIAL ACTION PLAN

The alternative Remedial Action Plan (RAP) proposed by the ECC Settlers Steering Committee for the ECC site addresses, in a technical- and cost-effective manner, all environmental concerns regarding the site, namely:

- o direct contact with soils containing volatile organics (VOCs), semivolatile organics, and heavy metals;
- o contamination of ground water by rain water percolating through soils containing VOCs, semivolatile organics, and heavy metals;
- o contamination of surface waters by overland migration of water in contact with soil containing VOCs, semivolatile organics, and heavy metals;
- o ingestion of ground water containing VOCs, semivolatile organics, and heavy metals; and
- o contamination of surface waters by discharge of ground water containing VOCs, semivolatile organics and heavy metals.

Additionally, the RAP complies with the Superfund Amendments and Reauthorization Act (SARA) of 1986 by removing VOCs from the soils and destroying them.

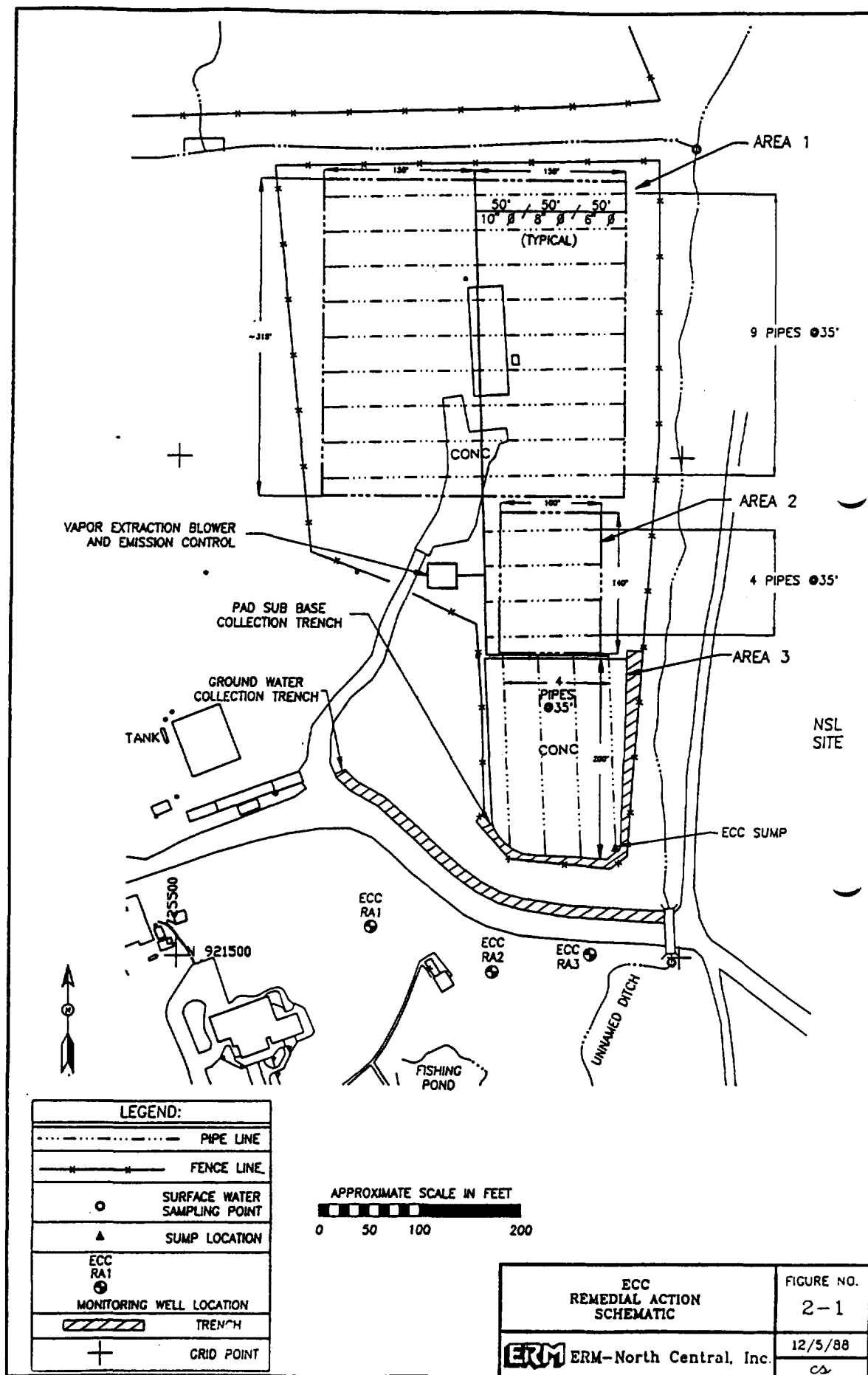


The word "contamination" is used herein to describe the uptake of chemical elements/compounds by soil, ground water or surface water at concentrations above those naturally present in these media.

The RAP includes the components listed below (Figure 2-1):

- o soil vapor extraction, concentration and destruction;
- o soil cover;
- o diversion of surface water runoff upgradient of concrete pad and collection of water from beneath the concrete pad;
- o shallow saturated zone ground water interception and collection;
- o access restrictions; and
- o ground water and surface water monitoring.

The plan presented herein is compatible with the proposed remedy for the Northside Sanitary Landfill (NSL) site. If necessary, modifications to the design will be implemented to merge both remedies appropriately.



## 2.1 Elements of the Alternative RAP

### 2.1.1 Soil Vapor Extraction, Concentration and Destruction

The objective of the soil vapor extraction activity is to remove and destroy existing VOCs from the soils (as provided herein) and thereby:

- 1) prevent contact with contaminated soils;
- 2) prevent migration of contaminants from the soils to the ground water; and
- 3) prevent migration of contaminants from the ground water to the surface water.

Soil vapor extraction will remove existing VOCs from the soils by enhancing and accelerating volatilization. To accomplish this, pipelines will be installed in trenches dug in the soils. The vacuum pressure developed by the extraction system will cause the VOCs in the soils to migrate to the pipelines and into the vapor treatment system. The vacuum is provided by a blower. The vapor treatment system will consist of preconcentration of the VOCs by adsorption on activated carbon and destruction of the VOCs by incineration.

The effectiveness of vapor extraction for VOC removal from the soils was demonstrated during a pilot test run by Terra Vac in June 1988 (Appendix A). The test showed an initial high VOC extraction rate of about 1.9 lb/d per foot of trench that

decreased with time to a steady-state rate of about 0.25 lb/d per foot of trench.

The vapor extraction system trenches will have the same cross-section as in the pilot test, i.e., a minimum of one-foot in width and a total of 9 feet in depth.

As shown in Figure 2-1, the site has been divided into three separate areas based on the site dimensions. The layout of the vacuum extraction system is also presented in Figure 2-1. All trenches will have a 35-foot separation, based on a radius of influence of 15 to 20 feet found during the pilot test (Appendix A). In addition, the sump located in the southeast corner of the site will also be connected to the vapor extraction system. The length of the trenches will be 150 feet, 100 feet and 200 feet in Areas 1, 2, and 3, respectively, based on the dimensions of each zone.

Trenches will be dug by a conventional backhoe using a narrow width bucket. The excavated soil will be placed directly in a lined, light dump truck and/or stockpiled for removal by a front-end loader. The excavated soil will then be placed in windrows on the existing concrete pad for subsequent vapor extraction (Area 3 on Figure 2-1) by installing an extraction pipe at the bottom of the windrows and connecting it to the vapor extraction system. The concrete debris will be placed on top of the concrete pad and leveled out. A maximum of 2200 cubic yards is expected to be excavated during trench construction.

A 4-inch slotted PVC pipe will be placed at the 8-foot level within the trenches to drain off any ground water that may accumulate in the trenches. This pipe will be connected to a 4-inch PVC riser which will be manifolded at the surface and connected to a positive displacement pump for water removal and discharge to the ground water interception system. Sampling

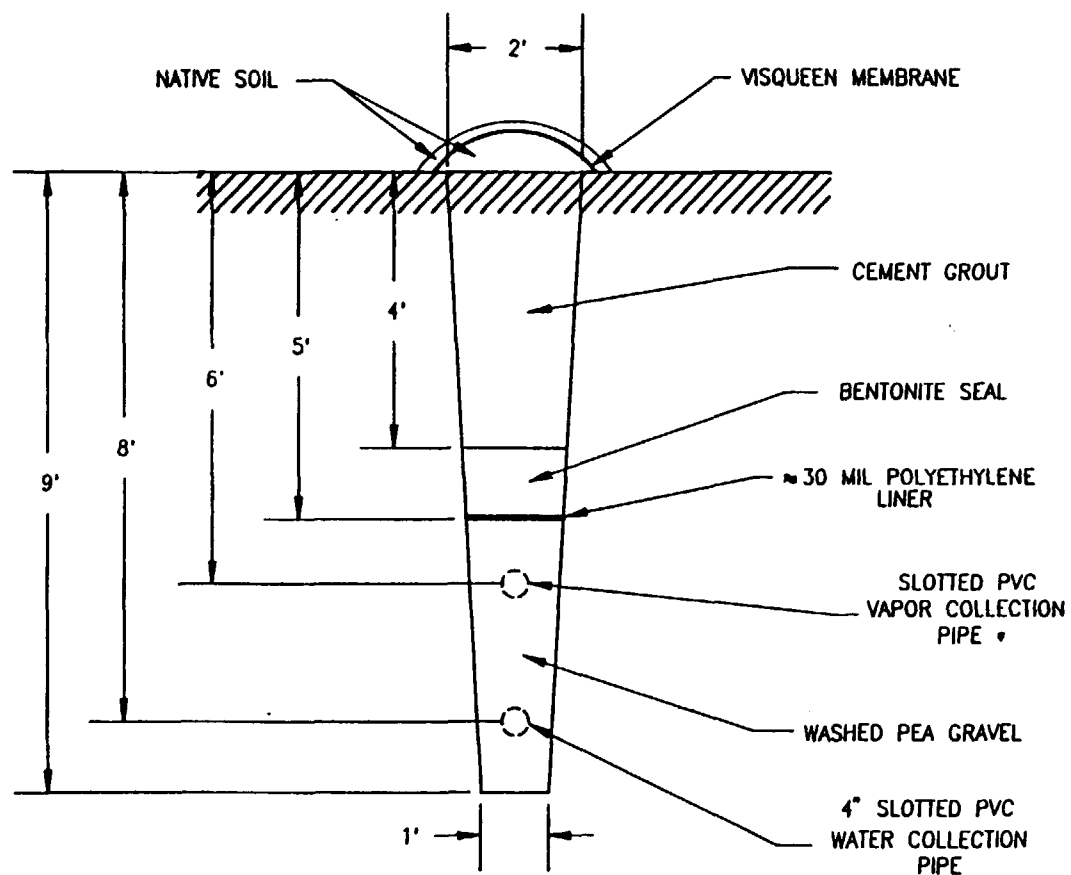
ports will be located at the northernmost locations of the manifold to allow for sampling of water collected in the northwestern corner of the site.

The vapor extraction pipe will be located at the 6-foot level and will consist of 50, 33 or 66 feet (in Areas 1,2 or 3, respectively) each of 6-, 8- and 10-inch slotted PVC pipe. The pipe size was selected to have a maximum velocity of 40 feet per second (fps) before transition to the next section. The pipe will be connected via a 10-inch riser to the surface for connection to the above ground vacuum manifold.

The trenches will be filled to the 5-foot level with pea gravel, which will be covered with a 30 mil or greater thickness polyethylene liner. A one-foot thick bentonite seal will be constructed on top of the liner using hydrated bentonite pellets. The trench will be filled to grade (approximately 4 feet) with a cement grout mixture and slightly mounded with native soil and visqueen membranes to prevent infiltration of surface water and vacuum breakthrough to the surface (Figure 2-2).

The trench vapors will be collected in an above ground manifold. The manifold will be insulated and will change in size from 1' x 1.25' at the start of the manifold system to a nominal 3' x 3' at the connection to the blower plenum, to accommodate the increased flow of vapors. The blower plenum will be designed to receive 25,000 SCFM at a nominal 4' x 4' size. The surface manifold will be sloped to allow the removal of any condensation which may form. The water collected in the condensation trap will be combined with the water collected in the trenches and conveyed to the Indianapolis sewage treatment system.

The vapor extraction blower motor and control system will be capable of removing a nominal 25,000 SCFM against a resistance of 3" Hg (equivalent to about 400 HP). After initial extraction



• SIZE VARIABLE, DEPENDING ON  
LOCATION (SEE FIGURE 6)

NOTE: NOT TO SCALE

ECC REMEDIAL ACTION  
VAPOR EXTRACTION  
TRENCH SCHEMATIC

FIGURE  
2-2

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CS

development during the pilot test, a steady-state soil resistance of 2-1/2" Hg was measured (Appendix A). Therefore, the piping and manifold system will be designed for a maximum resistance of 1/2" Hg (a higher vacuum). The controls will consist of motor control and starter with automatic shut-off in the event of: (1) excessive condensation in the vacuum system; (2) high or low suction pressure levels; and (3) failure of the VOC adsorption/concentration system.

The exhaust VOC adsorption/concentration system will collect the VOCs extracted from the soil and will consist of three 12-foot diameter unlined carbon steel vessels, each holding approximately 13,600 pounds of granular activated carbon. This is based on: (1) a flow rate of 25,000 SCFM; (2) concentrations of trichloroethene (TCE) and 1,1,1-trichloroethane (TCA) in the vapors of 34 ppmv and 16 ppmv, respectively, as detected during the pilot test; (3) a carbon capacity for these two compounds of about 25% by weight; and (4) an assumed total mass of VOCs of about 5500 pounds. This carbon system will be able to handle the entire mass of VOCs extracted from the soils during the remediation. Based on the soil samples collected during the RI, it was estimated that about 4700 lb of VOCs were present in the soils (Table 2-1). Therefore, the amount of carbon in the system is about 20% more than the theoretical required amount.

After vapor extraction is completed, the spent carbon containing the extracted VOCs will be transported in accordance with RCRA and any other applicable requirements to a licensed off-site RCRA facility. At the facility, the VOCs will be stripped and destroyed and the carbon regenerated by high temperature incineration.

Samples of the extracted vapor and the exhaust vapor will be collected daily during the first week of operation, weekly for the following 4 weeks, and monthly thereafter. Samples will be

TABLE 2-1

**ECC REMEDIAL ACTION PLAN  
ESTIMATE OF VOC MASS IN THE SOILS\***

Location	Sampling depth ft	Assumed contamination depth, ft	Total VOCs concentration ug/kg	Mass of VOCs lb
TP-1	1 - 1.5	2	102	0.014
TP-2	1 - 1.5	2	28	0.004
TP-3	1 - 1.5	2	107,700	14.827
TP-4	1 - 2	2.5	97,330	16.749
TP-4	2.5 - 3.5	4	16	0.004
TP-5	1 - 2	2	22,587	3.109
TP-5	2 - 3	1.5	291	0.030
TP-6	1 - 2	2	10,505,000	1,446.173
TP-6	2 - 3	1.5	22,450	2.318
TP-6	4 - 5	1.5	16	0.002
TP-7	1 - 2.5	2.5	231,000	39.751
TP-7	2.5 - 4	2	279,200	38.436
TP-8	1 - 2.5	2.5	67	0.012
TP-8	2.5 - 4	2	315,600	43.447
TP-9	1 - 3	3	14,604,000	3,015.694
TP-9	3 - 5	2.5	130	0.022
TP-10	1 - 3	3	108	0.022
TP-10	3 - 5	2.5	92	0.016
TP-11	1 - 3	3	130	0.027
TP-11	3 - 5	2.5	67	0.012
TP-12	1 - 3	3	34,690	7.163
TP-12	3 - 5	2.5	3,609	0.621
SB-01	2.5 - 4	3	3,303	0.682
SB-02	2.5 - 4	3	12,900	2.664
SB-03	2.5 - 4	3	70,070	14.469
SB-04	2 - 3.5	2.5	175	0.030
SB-06	2 - 3.5	2.5	220,900	38.013
SB-08	2.5 - 4	3	3,012	0.622
SB-09	2.5 - 4	3	60,390	12.470
SB0104	5.5 - 7	2	27	0.004
SB0204	5.5 - 7	2	34	0.005
SB0403	5 - 6.5	2	51	0.007
SB0805	7 - 8.5	2	188	0.026
SB0904	5.7 - 7	2	8,069	1.111
ESTIMATED TOTAL VOCs, lb				4,698.555

\* The area contaminated is assumed to be a 25'x25' square around each sampling location. TP = test pit; SB = soil boring. Soil concentrations from ECC RI.



analyzed for VOCs. Also, flow rate will be monitored and recorded, to provide enough data to calculate the mass of VOCs removed from the soils.

The time required for soil treatment has been estimated by calculating acceptable remaining concentrations using the procedures detailed in the Endangerment Assessment Section and Appendix E of the RI. Table 2-2 presents the maximum and average concentrations of indicator VOCs (TCE, tetrachloroethene (PCE), chloroform and methylene chloride) as detected in the soil samples during the RI investigation.

At the acceptable concentrations presented in Table 2-2, leaching of the compounds to the ground water and subsequent transport to the surface water will result in a risk at least two orders of magnitude lower than the predicted risk shown in Table 6-13 of the ECC RI. The values presented in Table 2-2 are very conservative considering that access restrictions will be maintained and a cover placed on the site.

As shown in Table 2-2, TCE and PCE are the most significant indicators. During the pilot tests (Appendix A), the steady state removal rates of trichloroethene and tetrachloroethene were 0.1 lb/day per foot of trench and 0.02 lb/day per foot of trench, respectively. Both compounds were detected at the highest concentration in trench TP-6, at a depth of 1-2 ft.

In order to estimate the duration of treatment, it was conservatively assumed that an area of 625 ft<sup>2</sup> around sampling locations has the same concentration of compounds, and therefore the mass of TCE at TP-6 is 660 lbs, and the mass of PCE at TP-6 is 90 lbs. For a 99.92% removal of TCE (Table 2-2), the current maximum mass will have to be reduced to 0.6 lb, which at a rate of 0.1 lb/day per foot of trench will take about 265 days (using a trench length of 25 ft crossing the area). Similarly, for PCE

TABLE 2-2

**ECC REMEDIAL ACTION PLAN**  
**CALCULATION OF ACCEPTABLE REMAINING SOIL CONCENTRATIONS**  
**BASED ON DATA AND METHODOLOGY IN THE ECC RI**

<u>Parameter</u>	<u>Compound (1)</u>			
	<u>TCE</u>	<u>PCE</u>	<u>CHLO</u>	<u>MECH</u>
Maximum concentration, ug/kg	4,800,000	650,000	2,900	310,000
Location of maximum concentration	TP6(1-2')	TP6(1-2')	SB02(2.5-4')	TP3(1-3')
Excess risk identified in Tables 2 and 4 of Appendix E of the ECC RI, maximum concentration (2)	1.2 E-3	3.0 E-4	2.6 E-6	2.5 E-6
Average concentration, ug/kg	354,300	52,900	370	32,800
Excess risk identified in Tables 2 and 4 of Appendix E of the ECC RI, average concentration (2)	8.8 E-5	2.4 E-5	3.4 E-7	2.7 E-7
Concentration for acceptable risk, calculated, (2) ug/kg	4,000	2,100	1,100	124,000
Required removal, %				
Maximum concentration	99.92	99.68	62	60
Average concentration	99.0	96.0	--	--

- (1) TCE = Trichloroethene  
PCE = Tetrachloroethene  
CHLO = Chloroform  
MECH = Methylene Chloride

- (2) Based on ingestion of 1 gram of soil per day by a 70 Kg person over a period of 70 years (an intake rate of 0.013 g/Kg/d).

the required time will be about 180 days. If lower concentrations are present, the treatment duration will be reduced accordingly.

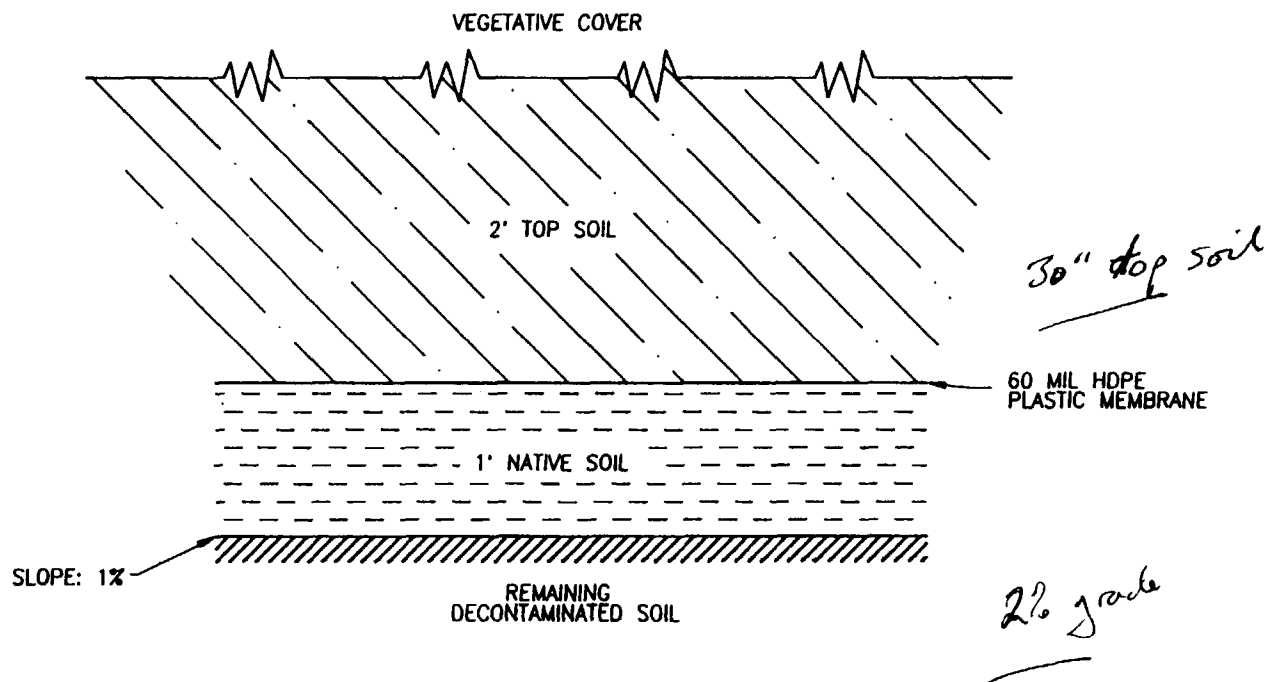
The soil vapor extraction system will be operated until calculations using the vapor chemical analyses and flow rate, and water results from the sampling ports in the northern section of the water manifold show that the amount of contaminants removed is equivalent to having soil concentrations below the levels shown in Table 2-2. Appendix B shows an example of how these analyses will be used.

#### 2.1.2 Soil Cover

Soil cover installed over the site will:

- o prevent human contact with remaining contaminated soil;
- o prevent contamination of surface runoff;
- o reduce the infiltration of water through the soils;
- o promote evapotranspiration;
- o promote drainage of rain water away from the site; and
- o mitigate erosion.

The soil cover will consist of a one-foot layer of the highly impermeable native soil, 60 mil HDPE plastic membrane and a 2-foot layer of top soil to support vegetation (Figure 2-3). The native soil used will be the silty clay till available in the



ECC REMEDIAL ACTION  
CROSS SECTION OF SOIL COVER

FIGURE  
2-3

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area, which can be compacted by standard methods to a permeability of  $10^{-7}$ . If soil from the NSL borrow area is not available, material with similar performance will be obtained from the nearest source.

Prior to placing the soil cover, the following activities will be conducted: (1) the existing building will be demolished and the pieces disposed off-site; (2) the existing tanks will be scrapped and the metal recycled off-site; (3) the site will be graded to fill existing depressions and eliminate sharp grade changes; and (4) the site will be sloped at about 1% to promote drainage.

The cover will be installed over all the site, including the concrete pad, after soil remediation is completed. Approximately 10,600 cubic yards (cy) of native soils, 21,000 cy of top soil and about 23,000 square yards of plastic membrane will be required. Vegetation to be established will be characterized by fibrous, shallow, laterally growing roots, such as grass.

#### **2.1.3 Runoff Control at and Collection of Water from Beneath the Concrete Pad**

These activities have the following objectives:

- o prevent the influx of surface runoff from the northern portion of the site into the subbase beneath the concrete pad;
- o eliminate the concrete pad subbase as a potential migration route for contaminants; and
- o collect the water that may become contaminated by flow through the subbase beneath the concrete pad.

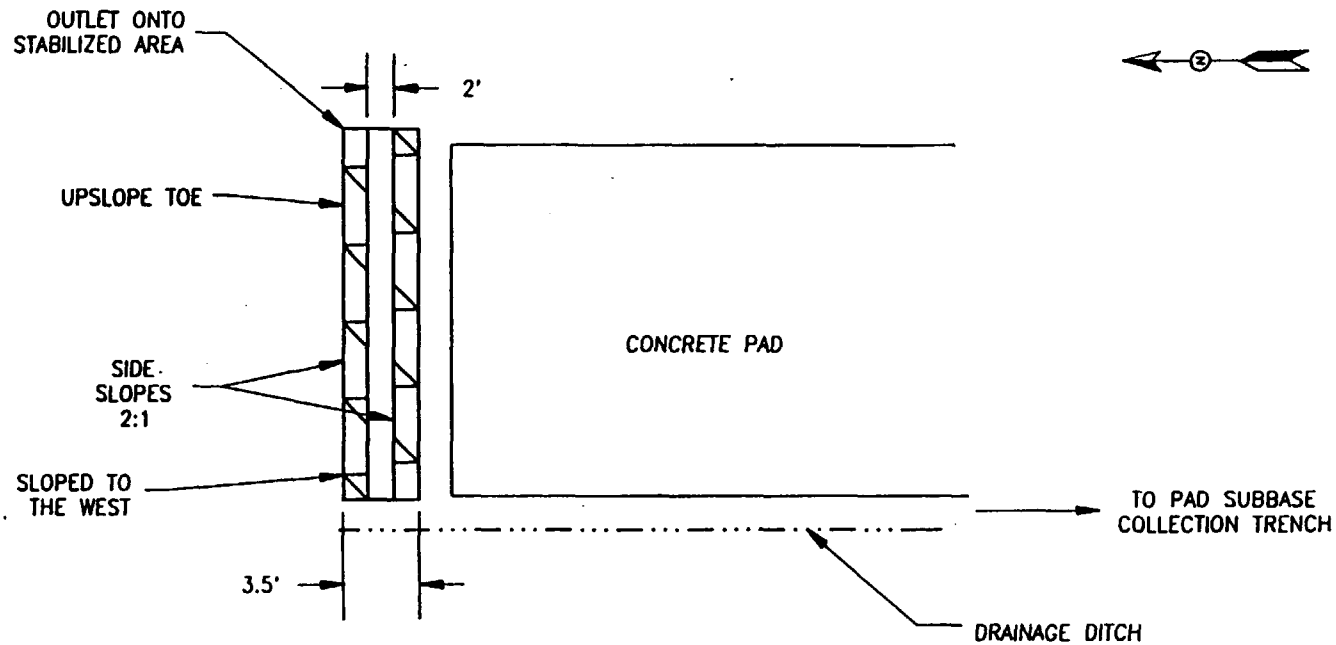
Surface water runoff from the northern part of the site largely flows south, where an existing berm along the north edge of the concrete pad redirects runoff to a drainage ditch west of the site. The existing berm will be substituted with a concrete berm to ensure that runoff cannot infiltrate beneath the concrete pad (Figure 2-4). This will essentially eliminate the generation of contaminated runoff from the subbase, which flows into the USEPA installed sump located at the south end of the pad.

An estimated 0.1 gpm will be diverted by this system, assuming a drainage area equal to 1/2 of the northeastern section of the site will drain towards the concrete pad (approximately 20,800 ft<sup>2</sup>), a runoff coefficient of 0.1 and a precipitation rate of 40 in/year.

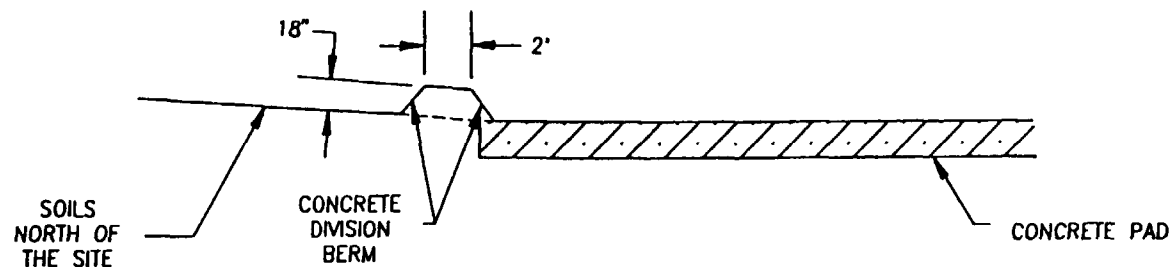
Prior to placement of the soil cover, the diverted surface runoff will be directed to the pad subbase collection trench to be ultimately conveyed to the Indianapolis Wastewater Treatment Plant. Subsequent to cover placement, surface water runoff will be directed, as storm water runoff, to Finley Creek.

In addition to the diversion of surface runoff, the larger cracks in the concrete pad will be sealed, and a lined collection trench approximately 4' deep by 1' in width will be installed along the south and southeast portions of the concrete pad (Figure 2-5) to intercept ground water flow in the pea gravel layer. The trench will be sloped to the southeastern corner of the pad. The water collected from this trench will be analyzed periodically, as presented in Section 2.1.4. The water will then be mixed with the rest of the water from the site and conveyed to the Indianapolis sewerage system for final treatment.

Once the surface water diversion system is installed, the amount of water flowing into this trench will be negligible. Initially, a flow of 0.06 gpm is estimated based on a precipitation of 40



PLAN SECTION



CROSS SECTION

NOTE: NOT TO SCALE

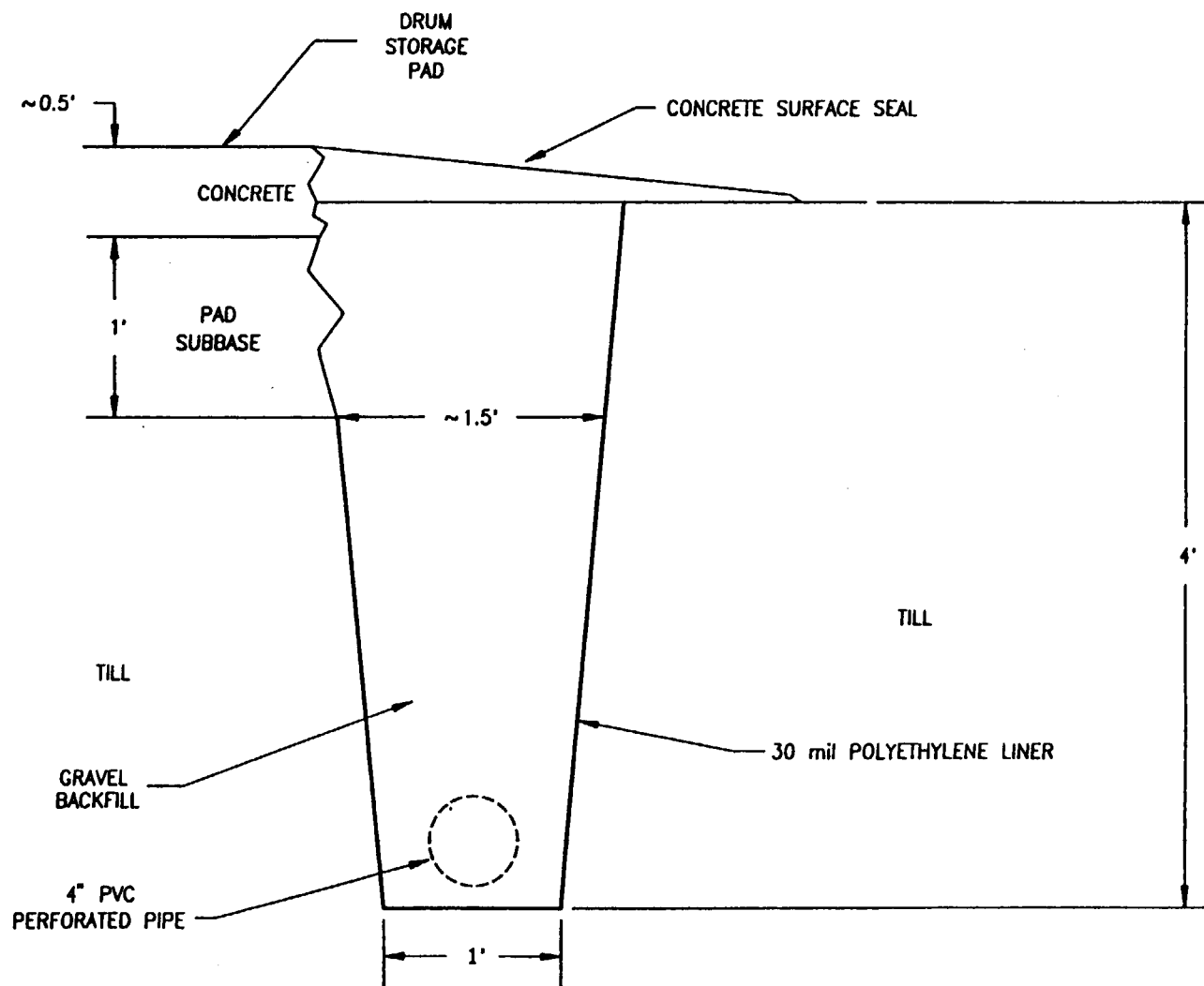
ECC REMEDIAL ACTION  
SURFACE WATER RUNOFF  
DIVERSION BERM

FIGURE  
2-4

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NOTE: ALL MEASURES APPROXIMATE

ECC REMEDIAL ACTION  
CONCRETE PAD DRAIN

FIGURE  
2-5

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in/yr, a 5% infiltration of rain water through cracks and around the edges of the pad , and a surface area of 27,300 ft<sup>2</sup>.

#### 2.1.4 Shallow Saturated Zone Ground Water Interception and Collection

The objective of the interception trench is to collect ground water from the saturated till.

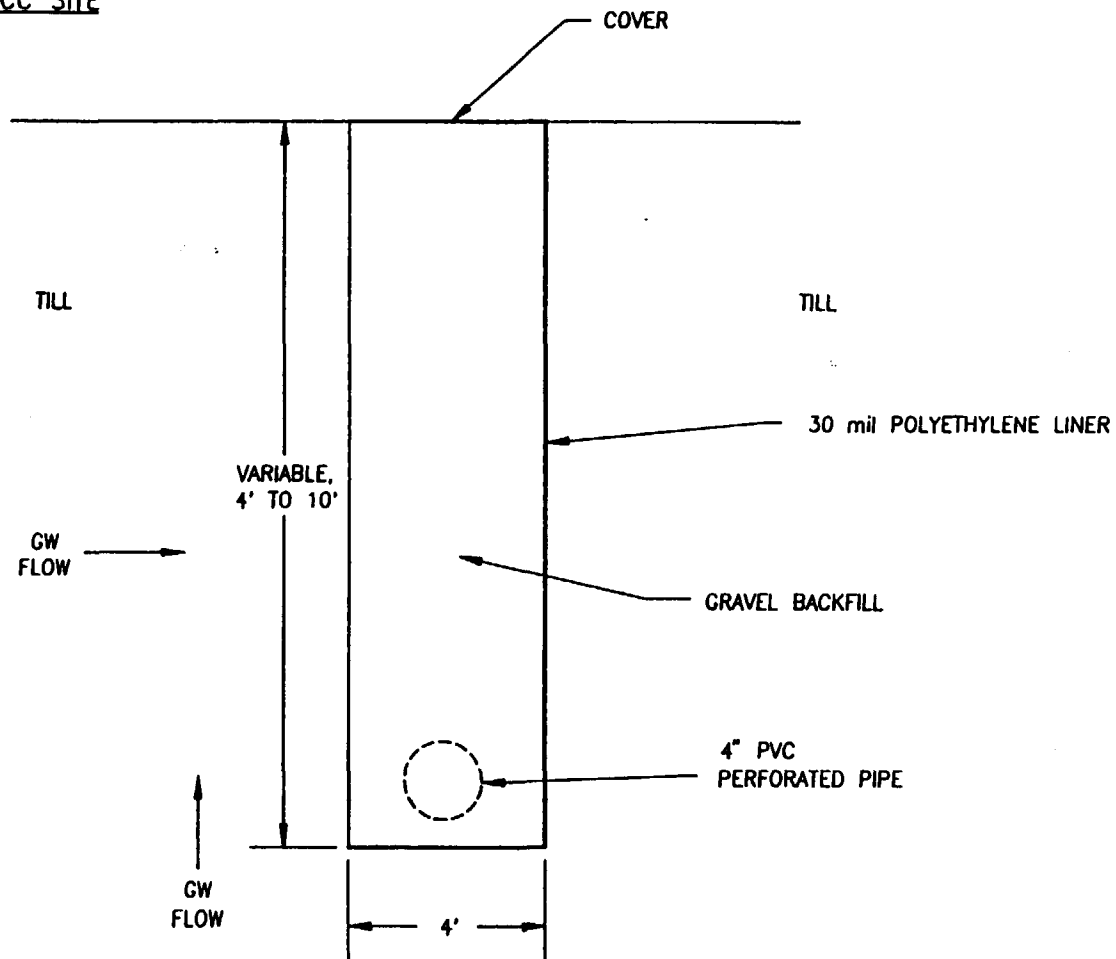
The ground water interception system will consist of a trench extending east-west south of the ECC site along the north side of the NSL access road (Figure 2-1). Access to NSL will be maintained at all times during construction and later operation of the trench system. The trench will be approximately 330 feet in length, 4 feet in width and will be variable in depth depending upon till thickness.

A schematic of the trench components is shown in Figure 2-6. A cross-section of the trench is presented in Figure 2-7. The eastern termination details of the trench will be compatible with the NSL design details as shown in Section 3.0 (to be prepared). If the till is continuous at the southeastern corner of ECC, the ground water interception trench will be tied to the NSL ground water hydraulic barrier described in the NSL Statement of Work.

A 4-inch PVC perforated pipe will be installed at the bottom of the trench. Gravel will be used for backfilling the trench. A 30-mil polyethylene liner will be installed in the south and lower boundaries of the trench to prevent collection of uncontaminated, downgradient water (Figure 2-6).

The flow of water into the trench is estimated to be 0.70 gpm (Appendix C). Three components of flow were included: (1) site area ground water flow; (2) induced lateral flow due to the

ECC SITE



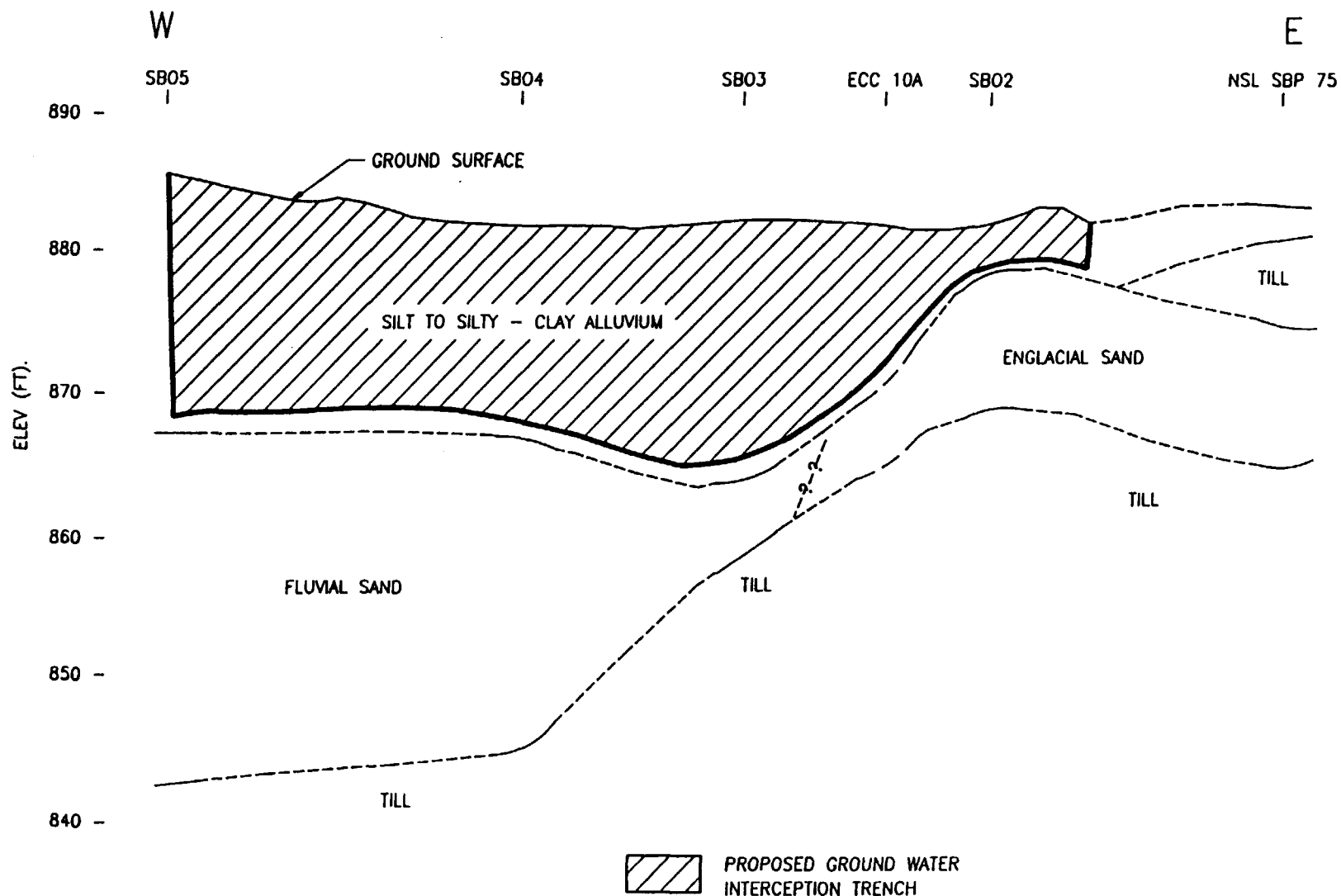
NOTE: NOT TO SCALE

ECC REMEDIAL ACTION  
GROUND WATER  
INTERCEPTION TRENCH

FIGURE  
2-6

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ADAPTED FROM: FIGURE 11A, CH2M-HILL, 1988  
DRAFT TECHNICAL MEMORANDUM NO. 2

NOTE: THE ACTUAL LOCATION OF THE TIE OF THE EASTERN  
TRENCH END TO THE NSL REMEDIATION, IF ANY, WILL  
BE DETERMINED DURING THE REMEDIAL DESIGN.

SCALE IN FEET  
0 10 25 50

GEOLOGIC CROSS-SECTION  
ILLUSTRATING LOCATION OF  
GROUND WATER  
INTERCEPTION TRENCH

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FIGURE  
2-7

12/1/88  
CS

trench; and (3) recharge due to precipitation and upward flow from the sand and gravel unit.

The water collected in the trench will then be conveyed in accordance with IDEM requirements to the Indianapolis sewerage system for final treatment.

Water from the ground water interception trench, the trench around the concrete pad, and the vapor extraction system will be sampled and analyzed for the TCL parameters weekly, if possible, during the first 2 months after installation to determine the levels of contamination in the collected ground water. Afterwards, a monitoring program will be implemented according to the City of Indianapolis sewerage system requirements.

The ground water interception trench will be operated during the same time as the vapor extraction system. After that, the need for continued operation of the interception trench will be assessed based on the volume and quality of the water collected compared to the associated risk calculated using the methodology in the site's Endangerment Assessment as presented in the ECC RI.

#### 2.1.5 Access Restrictions

The objectives of implementing access restrictions are to:

- o minimize contact with contaminated soils and water containing VOCs, semivolatile organics, and heavy metals; and
- o prevent further contaminant migration that could result from site excavation and development.

Access restrictions will consist of:

- o fencing around the site perimeter and posting of signs;
- o filing of appropriate restrictions with County Registrar of Deeds prohibiting usage of site for excavation and development;
- o filing of appropriate restrictions with County Registrar of Deeds prohibiting usage of ground water from the saturated till and the underlying sand and gravel; and
- o filing of appropriate restrictions with County Registrar of Deeds prohibiting installation of new water wells other than monitoring wells.

Ground water use restrictions will extend to areas where utilization of the shallow ground water could potentially result in contamination being drawn to these locations.

#### 2.1.6 Ground Water and Surface Water Monitoring

The monitoring activities will:

- o detect VOCs migration to the ground water and surface water; and
- o verify and monitor the effectiveness of the remediation.

Contingency plans should the target levels be exceeded are shown in Section 3.0 (to be prepared).

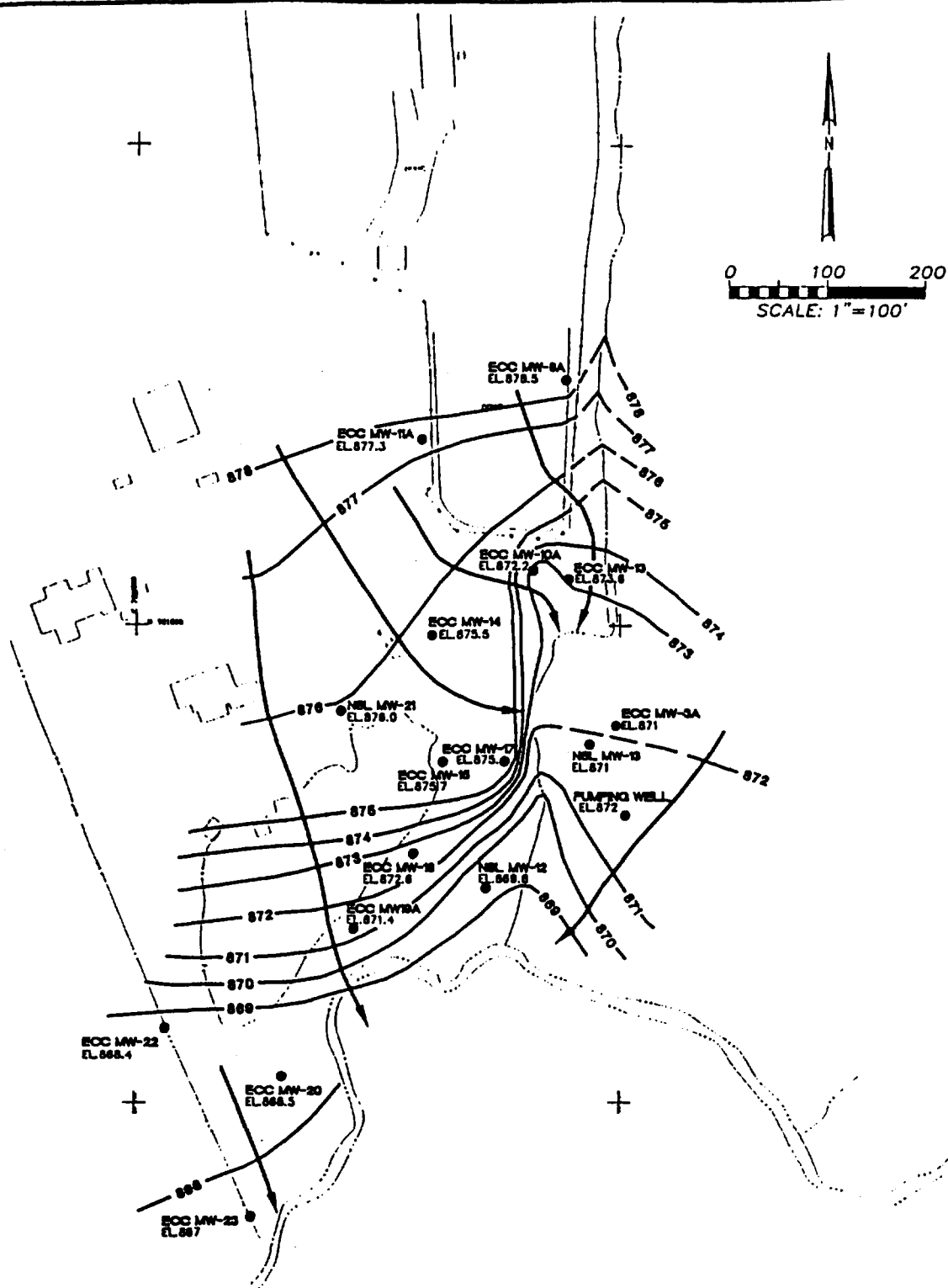
The ground water monitoring network will consist of three (3) wells, which will be located downgradient of the southern limit of the ECC property and south of the Northside Sanitary Landfill (NSL) access road (Figure 2-1). These wells will be installed in the sand and gravel unit underlying the saturated surface till. The wells will be 2-inch PVC and will screen the total thickness of the sand and gravel unit.

The location of the monitoring wells is based on the ground water elevation contours shown in Figure 2-8. As part of the remediation of the NSL site, it has been proposed that the Unnamed Ditch be isolated in a concrete conduit. Without the Unnamed Ditch as a discharge zone, ground water flow beneath the eastern side of the ECC site will be southerly. Therefore monitoring wells located south of the site (Figure 2-1) appropriate.

Samples from these wells will be collected quarterly during soil remediation and analyzed for the parameters in the Target Compound List (TCL). Monitoring will be continued on a semi-annual basis as specified below.

The surface water will be monitored by sampling the Unnamed Ditch just upgradient of the culvert proposed by NSL for the Unnamed Ditch and at the closest manhole access downstream from the ECC site (Figure 2-1). Surface water will be sampled at the same frequency as ground water and analyzed for the same parameters.

The semi-annual ground and surface water monitoring will cease when the results for two (2) consecutive semi-annual sampling events, after the initial five (5) years of sampling, are shown to be statistically below the threshold values shown in Section 2.2. Any sampling conducted after this time will be dependent upon statutory requirements.



# LEGEND

- 868 — POTENTIOMETRIC SURFACE CONTOUR FOR SAND AND GRAVEL AQUIFER. CONTOUR INTERVAL: 1 FOOT.
- - - 868 - - - INFERRED POTENTIOMETRIC SURFACE CONTOUR
- DIRECTION OF GROUNDWATER MOVEMENT IN SURFICIAL AQUIFER

NOTE: Contours have been drawn to suggest that the pond is not hydraulically connected to the sand and gravel aquifer. This relationship has not been fully established.

From CH2M HILL Technical Memorandum  
No. 2, dated September 16, 1988.

POTENTIOMETRIC SURFACE MAP OF  
UPPER SAND AND GRAVEL AQUIFER

ERM North Central, Inc.

FIGURE  
2-8

10/27/88  
CS

## **2.2 Remedial Action Performance Standards**

To accomplish remediation of the site, the following performance standards will have to be met:

- o the average concentrations of TCE, PCE, chloroform and methylene chloride in the soils, as determined by vapor measurements, ground water monitoring, and calculations, will be reduced to the following levels: TCE - 4000 ug/kg; PCE - 2100 ug/kg; chloroform- 1100 ug/kg; and methylene chloride - 124,000 ug/kg;
- o the cover will reduce infiltration through the site soils. The infiltration reduction calculations are presented in Section 3.0 (to be prepared);
- o contamination above the levels shown in Table 2-3 attributable to the ECC site in the surface water south of the site will be prevented;
- o contamination above the levels shown in Table 2-3 in the sand and gravel unit beyond the interception trench will be prevented.

## **2.3 Project Schedule**

An estimated schedule for Remedial Action implementation is shown in Figure 2-9. The final schedule is shown in Section 3.0 (to be prepared).



TABLE 2-3  
ECC SITE  
SURFACE AND GROUND WATER ACCEPTABLE LEVELS\*

<u>Compound</u>	<u>Acceptable Levels (ug/l)</u>	<u>Reference</u>
1,1,1-Trichloroethane	5,280	1
1,1,2-Trichloroethane	41.8	2,a
Chloroform	15.7	2,a
Benzene	40	2,a
Ethylbenzene	3,280	2,b
Methylene chloride	15.7	2,a
1,1-Dichloroethene	1.85	2,a
Trichloroethene	80.7	2,a
Tetrachloroethene	8.85	2,a
Toluene	3,400	1
Phenol	570	1
4-Chloro-3-methyl phenol	1	1
Bis(2-Ethylhexyl) phthalate	C	3
Vinyl chloride	525	2
1,2-Dichloroethane	243	2
Di-n-butyl phthalate	C	3
Diethyl phthalate	C	3
Dimethyl phthalate	C	3
Naphthalene	620	3,d
Arsenic	0.0175	2
Chromium	11	3
Copper	26	3,e
Cyanide	5.2	3
Iron	1000	3
Lead	10	3,e
Nickel	100	2
Zinc	47	3,e

TABLE 2-3 (cont'd)

ECC SITE  
SURFACE AND GROUND WATER ACCEPTABLE LEVELS\*

- a = Based on carcinogenic protection.
  - b = Based on toxicity concentration.
  - c = The protection of aquatic life levels for phthalates, as a class, are 940 ug/l (acute lowest observed effects level) and 3 ug/l (chronic lowest observed effects level).
  - d = Chronic value
  - e = Based on water hardness of 250 mg/l  $\text{CaCO}_3$  equivalent.
- 
- 1 = One-tenth the 96 hour median lethal concentration. Use of one-tenth the 96-hour LC is based on State of Indiana Water Quality Standards, 330 IAC 1-1. 96-hr LC values from Verschueren K, 1983, Handbook of Environmental Data on Organic Chemicals.
  - 2 = Water Quality Criteria for the protection of human health, consumption of aquatic organisms, 1980 Ambient Water Quality Criteria, as revised in 50 FR 30784, July 29, 1985.
  - 3 = Water Quality Criteria for the protection of aquatic life. 1980 Ambient Water Quality Criteria, as revised in 50 FR 30784, July 29, 1985.

\*Taken from Table 1 of the ECC/NSL ROD, September, 1987.

# TASK:

# WEEKS FROM PROJECT INITIATION

## 1. INITIAL PREPARATIONS

## 2. CONSTRUCTION ACTIVITIES

- SOIL VAPOR EXTRACTION
- SOIL CAPPING
- RUNOFF CONTROL AT AND COLLECTION OF WATER FROM BENEATH THE CONCRETE PAD
- GROUND WATER INTERCEPTION
- ACCESS RESTRICTIONS
- MONITORING

## 3. OPERATION ACTIVITIES

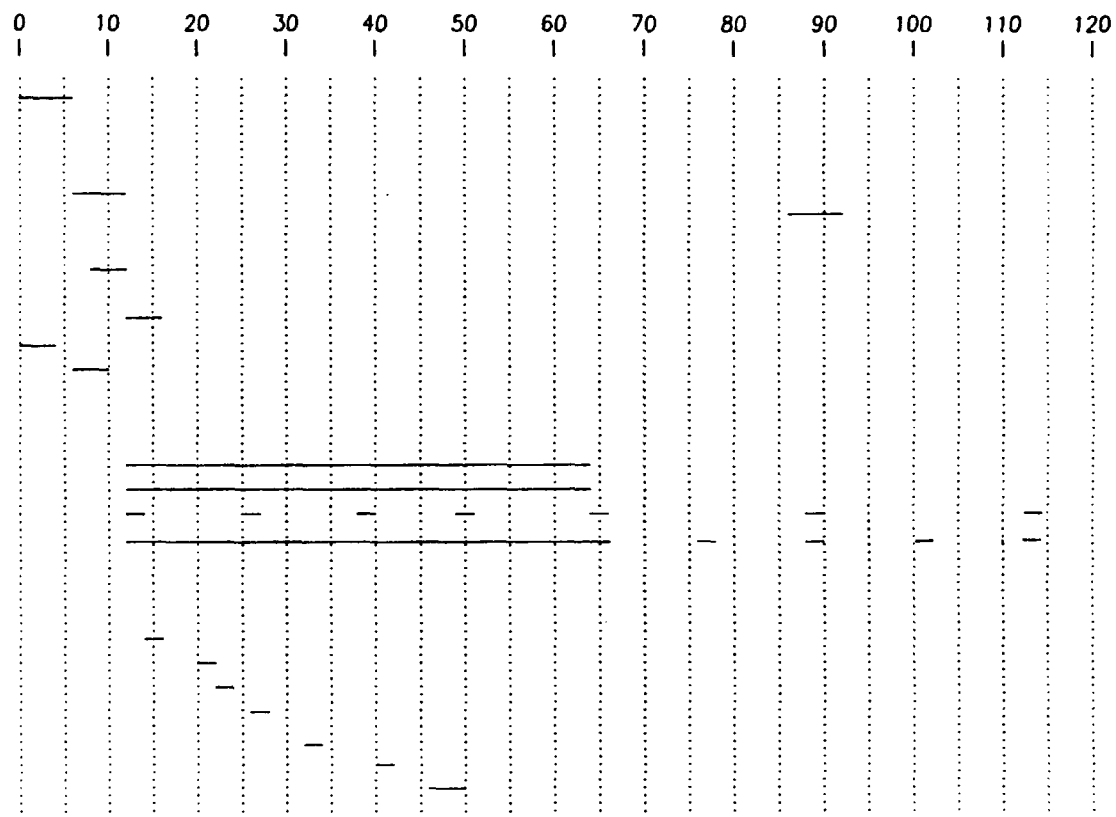
- SOIL VAPOR EXTRACTION
- GROUND WATER INTERCEPTION \*
- MONITORING \*\*
- OTHER

## 4. PROJECT ACCEPTANCE

- PREFINAL CONSTRUCTION CONFERENCE
- PREFINAL INSPECTION
- PREFINAL INSPECTION REPORT
- FINAL INSPECTION
- REMEDIAL ACTION REPORT
- PROJECT ACCEPTANCE
- DELETION OF SITE FROM NPL

\* WILL CEASE AS DESCRIBED IN SECTION 2.1.4.

\*\* SAMPLING WILL BE CONDUCTED SEMIANNUALLY AFTER WEEK 116 UNTIL AT LEAST FIVE YEARS OF SEMI-ANNUAL DATA ARE COLLECTED. SAMPLING AFTER THAT TIME WILL BE AS DISCUSSED IN SECTION 2.1.6.



ECC SITE  
ESTIMATED REMEDIAL ACTION  
IMPLEMENTATION SCHEDULE

FIGURE NO.

2-9



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**APPENDIX A**  
**TERRA VAC PILOT TEST**  
**AT**  
**ENVIRONMENTAL CHEMICAL AND CONSERVATION CORP.**  
**ZIONSVILLE, INDIANA**

TERRA VAC PILOT TEST  
AT  
ENVIRONMENTAL CHEMICAL AND CONSERVATION CORP.  
ZIONSVILLE, INDIANA

INTRODUCTION

This report discusses the results of the vapor extraction pilot test conducted by Terra Vac with ERM-North Central at the Environmental Chemical and Conservation Corporation (ECC) NPL site in Zionsville, Indiana. The report discusses the major project activities, data gathered, and significant findings in the following sections:

- I. Summary
- II. System Installation
- III. Vapor Extraction Operations
- IV. Analytical QA/QC
- V. Projection of Clean-Up Time

I. SUMMARY

The vapor extraction pilot test was successful in demonstrating the Terra Vac Process as a technically sound and cost effective method for removing volatile organics from the ECC site soils. Horizontal extraction wells were shown to be superior to vertical extraction wells for the site geology. Clean up time for the site using vapor extraction was estimated to be 300-400 days.

During Terra Vac's pilot test and operating period, approximately 548 pounds of VOCs were removed from the soil at the site. Tests show an approximate 20 foot radius of influence for horizontal

extraction wells. The extended run time on HEW-2 developed the data necessary to project clean up time. The vapor extraction operations began on June 13 and continued, with only minor shut downs, until July 20.

## II. SYSTEM INSTALLATION

During the week of June 1, Terra Vac personnel arrived on site to receive and procure materials for the job. Trenching began on June 7 and continued until June 8. Subsurface vapor monitoring wells and Vertical Extraction Well (VEW-1) were installed during the remainder of the week. Following extraction trench installation, the major components of the extraction system were manifolded together. Figure 1 is a drawing showing the layout of the test site.

During trench installation soil samples were taken and analyzed for VOCs using the headspace method. As expected, the VOC concentration was highly variable over the length of the trench. Table 1 is a summary of the chemical analyses of the soil samples.

## III. VAPOR EXTRACTION OPERATIONS

Appendix A is a daily summary of the system and the operation of each well. Appendix B contains operating and analytical data taken during the pilot test.

### A. Well Development

HEW-2 was initially developed for 22 hours. The results of the development period showed high VOC extraction rates and a radius of influence extending to approximately 15 feet. Following

development of HEW-2, vapor extraction from HEW-1 and VEW-1 was initiated as a combined development. The combined development continued for approximately four more days. The results of that development period indicated that HEW-1 had lower VOC extraction rates than HEW-2 but a comparable radius of influence. However, no significant radius of influence was measured from the vertical extraction well (VEW-1).

## B. Operations

Figure 2 is a plot of the Cumulative Pounds of VOC Extracted by the System versus Run Time. Approximately 548 pounds of VOC were removed from the soil at the site during Terra Vac's operations. After well development, operations focussed on HEW-2, where VOC concentrations were expected and found to be highest. HEW-2 remained in operation for a total of 31.4 days, with a total of 470.8 pounds of VOCs removed, as shown in Figure 3. The radius of influence stabilized at 15 to 20 feet.

Figure 4 and 5 show cumulative VOCs removed from HEW-1 and VEW-1. The short run times reflect both the slow development of VEW-1 and the decision to operate HEW-2 solely. Following development, the unexpectedly high flow rates from HEW-2 necessitated its solo operation so that the pilot system's effectiveness could be maximized.

Figure 6 shows HEW-2 VOC removal rates vs. run time. This type of curve is consistent with Terra Vac's previous experience. Early high rates decline to a relatively stable removal rate that slowly decreases (spikes before day 10 were caused by optimization procedures or short term shutdowns). Figure 7, showing initial and final rates for the major contaminants at HEW-2, indicates how these changes in VOC removal rate occur. There are substantial drops in rates from beginning to end for the more volatile components such as DCE, TCA, and TCE, while

rates for Toluene, PCE, and Xylenes have changed little or increased. The Total VOC Removal Rate dropped by 87% from its high point of 76 lb/day to a low point of 9.9 lb/day when the system was shut off.

The extracted VOCs were exhausted using a dispersion stack with agreement from the Indiana Department of Environmental Protection. Air quality testing was performed at the site boundary by ERM-North Central using a hand held vapor analyzer with a photoionization detector. At no time did concentrations of the indicator compounds at the site boundary exceed allowable limits.

#### IV. ANALYTICAL QA/QC

Several attachments (1-4) are included in this report that outline GC parameters, sampling and QC procedures. Vapor analyses were by direct injection of samples into a Shimadzu GC-9A gas chromatograph equipped with a flame ionization detector and utilizing a capillary column for separation of the compounds. Calibration checks or recalibrations were done daily, prior to sampling. All sample syringes were air purged via pump, with several blanks run to verify efficiency of purging procedure. Questionable results (i.e., an unusual change in concentration) was cause to run a syringe blank and resample to verify initial analysis.

#### V. PROJECTION OF CLEAN-UP TIME

Based upon data collected from the operation of HEW-2, the clean-up time for the site using vapor extraction technology is projected to be approximately 350 days.

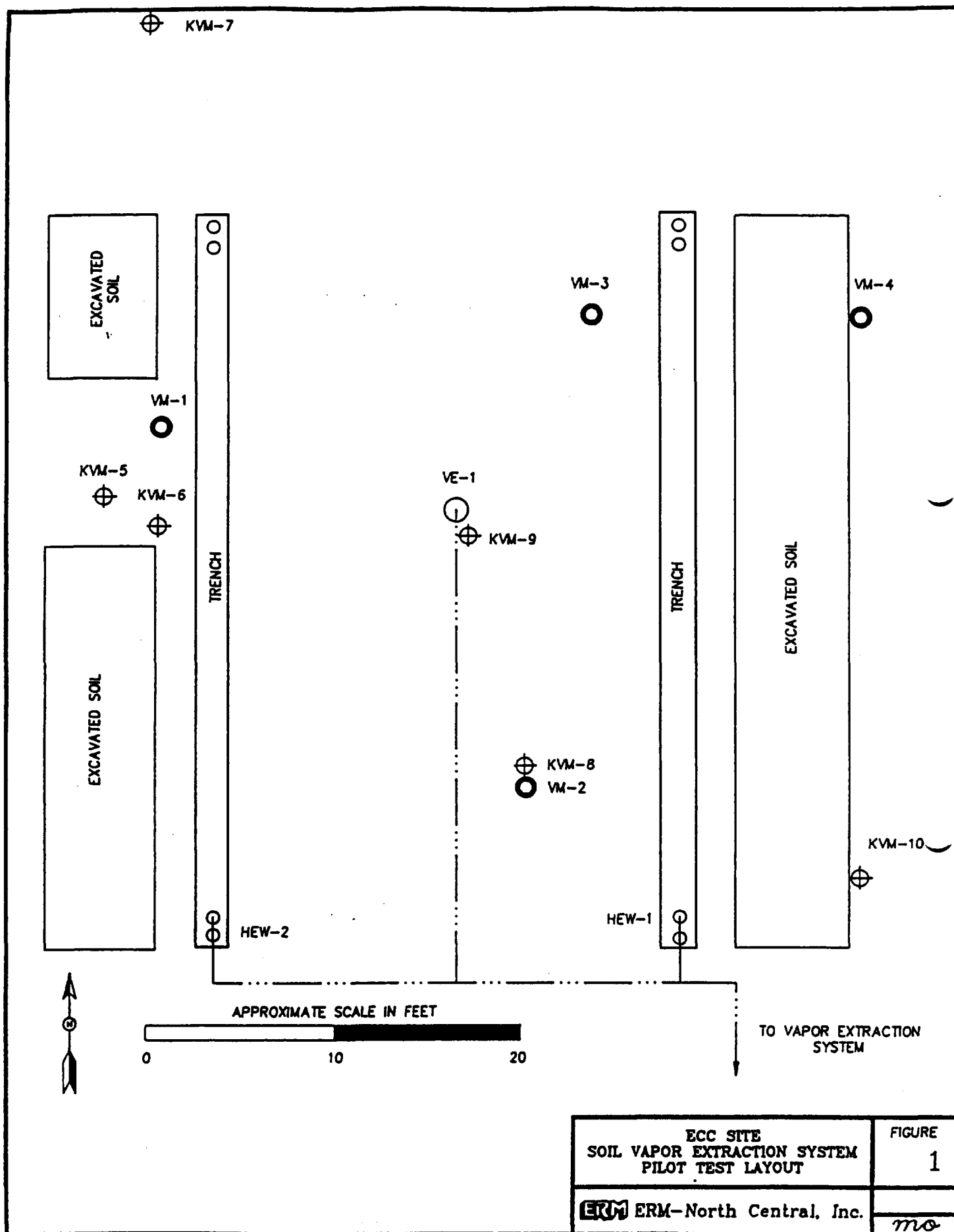


TABLE ONE

ECC SOILS DATA  
TERRA VAC PILOT TEST

HEW-1 SOIL SAMPLE ID	HEW-1 DEPTH FT.	HEW-1 DCE ppm	HEW-1 TCA ppm	HEW-1 BZ ppm	HEW-1 TCE ppm	HEW-1 TOL ppm	HEW-1 PCE ppm	HEW-1 mp-XYL ppm	HEW-1 TOTAL ppm
T1-3-3	3.0	.2	3.2	NA	7.7	1.9	4.5	1.9	19.4
T1-6-7	7.0	.4	2.4	NA	4.5	2.1	9.6	2.2	9.4
T1-6-9	9.0	.1	.0	NA	.0	.0	.1	.0	.2
T1-12-4	4.0	2.4	59.6	NA	99.7	5.1	187.5	2.3	166.7
T1-12-7	7.0	4.5	63.9	NA	125.0	5.9	155.2	2.2	199.3
T1-20-2	2.0	6.8	18.3	NA	59.0	10.6	2.4	2.9	94.5
T1-25-7	7.0	3.9	8.8	NA	24.5	4.0	11.5	1.7	41.1
T1-35-5	5.0	7.7	45.6	NA	7.9	4.6	4.0	1.8	65.7
T1-35-6	6.0	62.3	96.2	NA	49.7	9.4	103.1	3.8	217.6
T1-40-3	3.0	6.3	4.3	NA	2.0	.5	1.6	.2	13.1
T1-40-5	5.0	1.5	22.4	NA	2.6	1.0	1.1	.5	27.5
T1-40-7	7.0	.7	67.4	NA	9.0	6.9	1.9	.6	84.1

HEW-2 SOIL SAMPLE ID	HEW-2 DEPTH FT.	HEW-2 DCE ppm	HEW-2 TCA ppm	HEW-2 BZ ppm	HEW-2 TCE ppm	HEW-2 TOL ppm	HEW-2 PCE ppm	HEW-2 mp-XYL ppm	HEW-2 TOTAL ppm
T2-5-3	3.0	.6	3.6	NA	6.5	3.3	1.5	2.3	14.0
T2-5-7	7.0	1.1	180.8	NA	10.6	19.7	4.9	8.8	212.1
T2-5-9	9.0	.2	5.1	NA	8.5	1.2	8.7	1.0	15.0
T2-15-2	2.0	1.5	109.6	NA	6.8	15.3	2.1	3.4	133.2
T2-15-8	8.0	1.1	83.0	NA	16.2	13.8	2.2	4.9	114.1
T2-18-5	5.0	1.1	40.2	NA	12.0	.8	1.9	.1	54.2
T2-22-3	3.0	.4	54.7	NA	20.1	4.0	4.7	1.8	79.1
T2-22-8	8.0	.1	1.8	NA	.7	.4	.2	.2	3.0
T2-35-3	3.0	1.6	37.9	NA	58.7	18.1	26.4	10.1	116.2
T2-35-4	4.0	.6	54.5	NA	333.9	25.5	35.0	6.4	414.4
T2-35-7	7.0	1.4	68.9	NA	71.3	19.2	20.6	13.7	160.7
T2-43-5	5.0	2.5	153.5	NA	24.8	13.3	5.6	5.8	194.1
T2-45-2	2.0	.9	68.9	NA	21.7	12.5	3.8	4.1	103.9
T2-45-6	6.0	1.6	116.8	NA	15.4	14.1	2.5	4.6	147.8



# TOTAL LBS VOC REMOVED TERRA VAC - ECC PILOT TEST

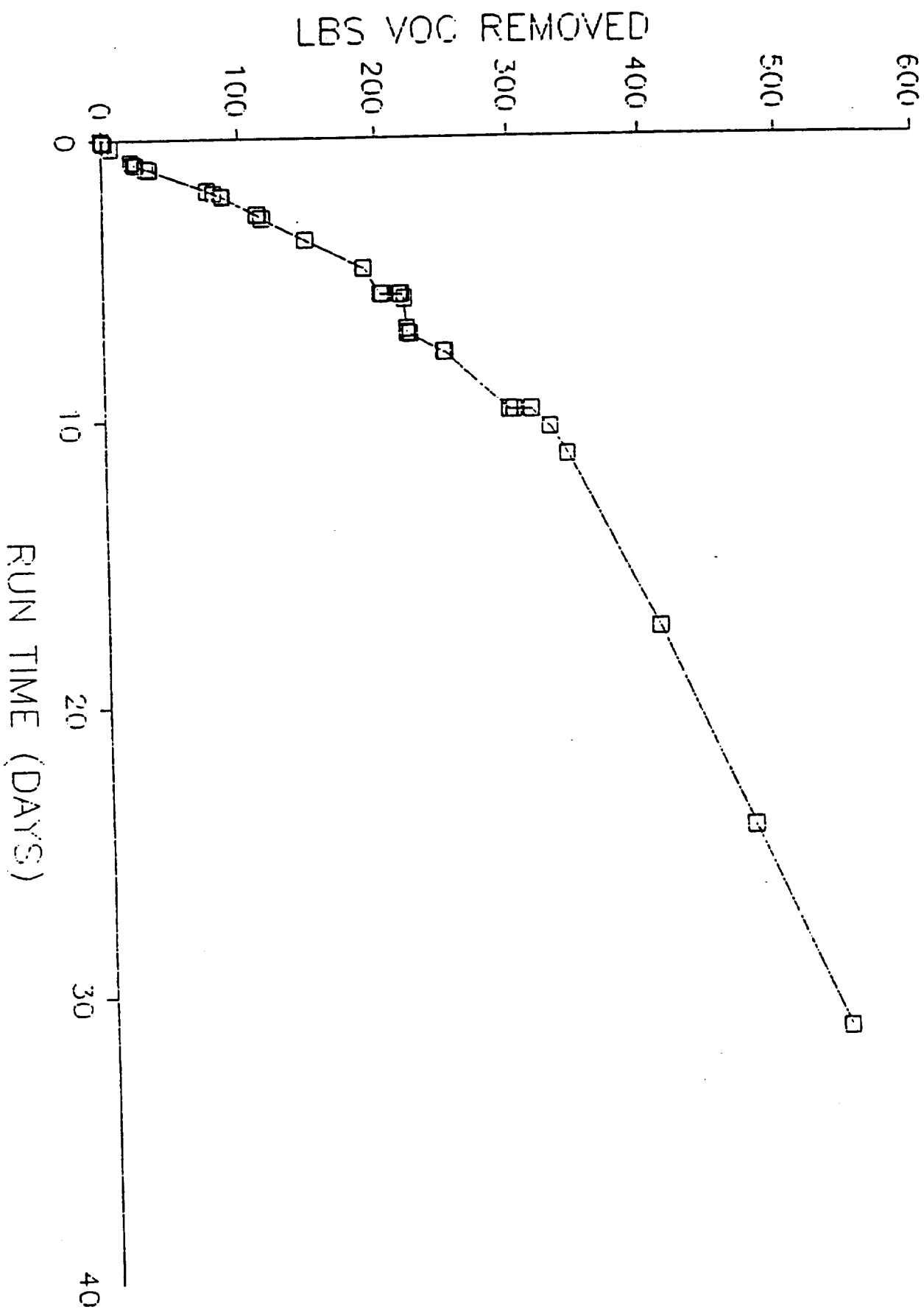


FIGURE 2

HEW--2 LBS VOC REMOVED  
TERRA VAC HORIZONTAL EXTRACTION WELL

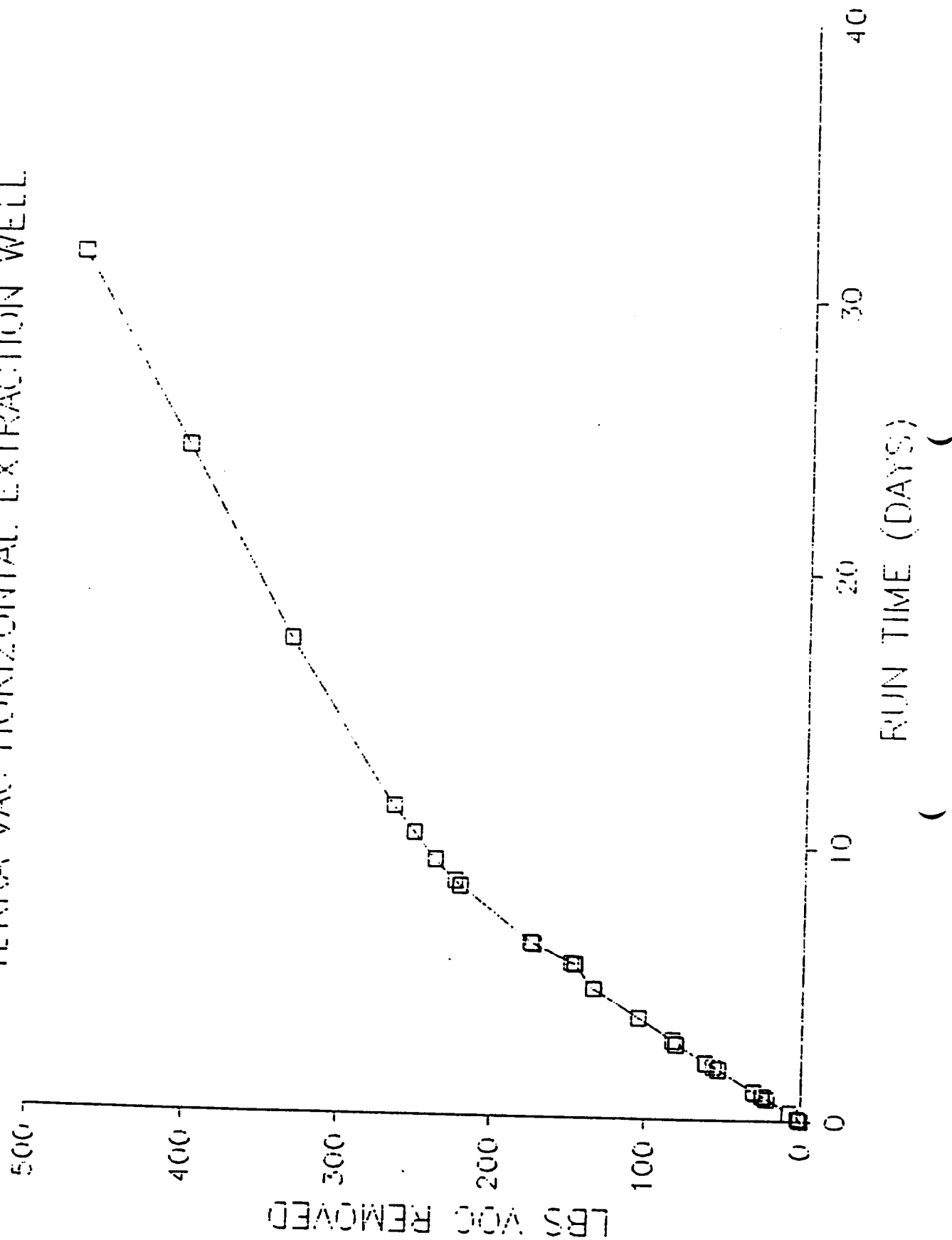


FIGURE 3

HEW--1 LBS VOC REMOVED  
TERRA VAC HORIZONTAL EXTRACTION WELL

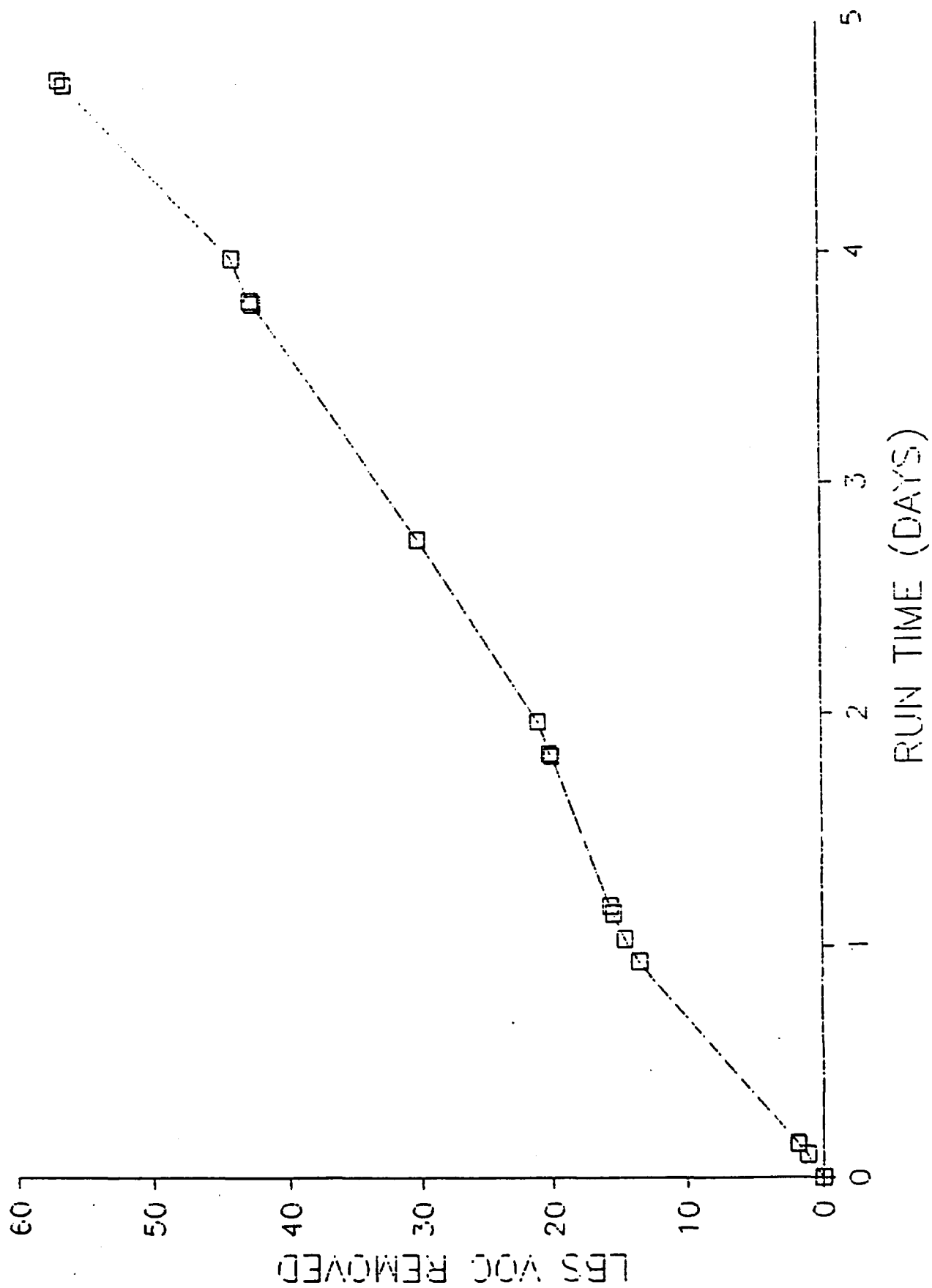


FIGURE 4

VEW-1 LBS VOC REMOVED  
TERRA VAC VERTICAL EXTRACTION WELL

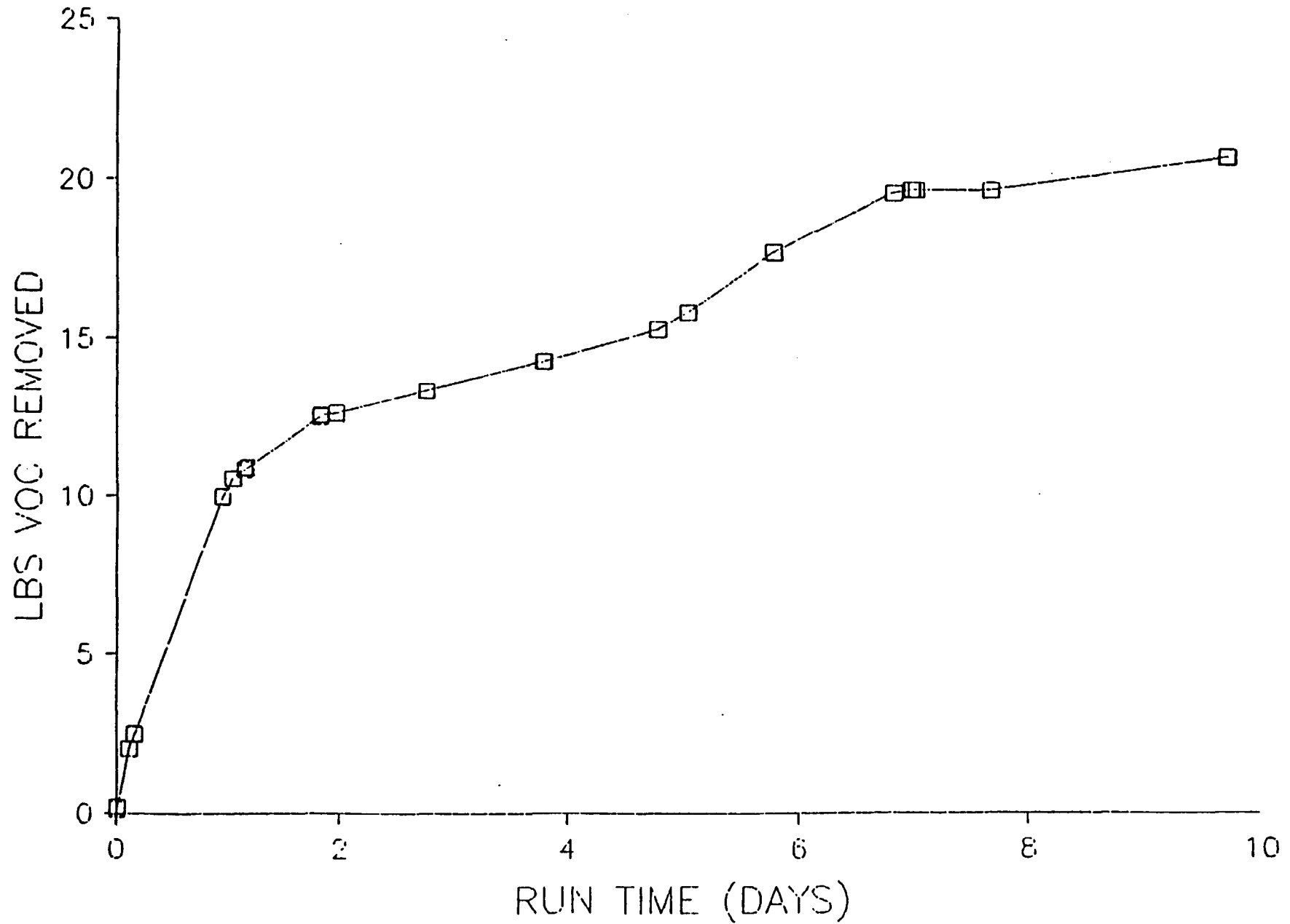


FIGURE 5

HEW-2 VOC REMOVAL RATES  
TERRA VAC HORIZONTAL EXTRACTION WELL

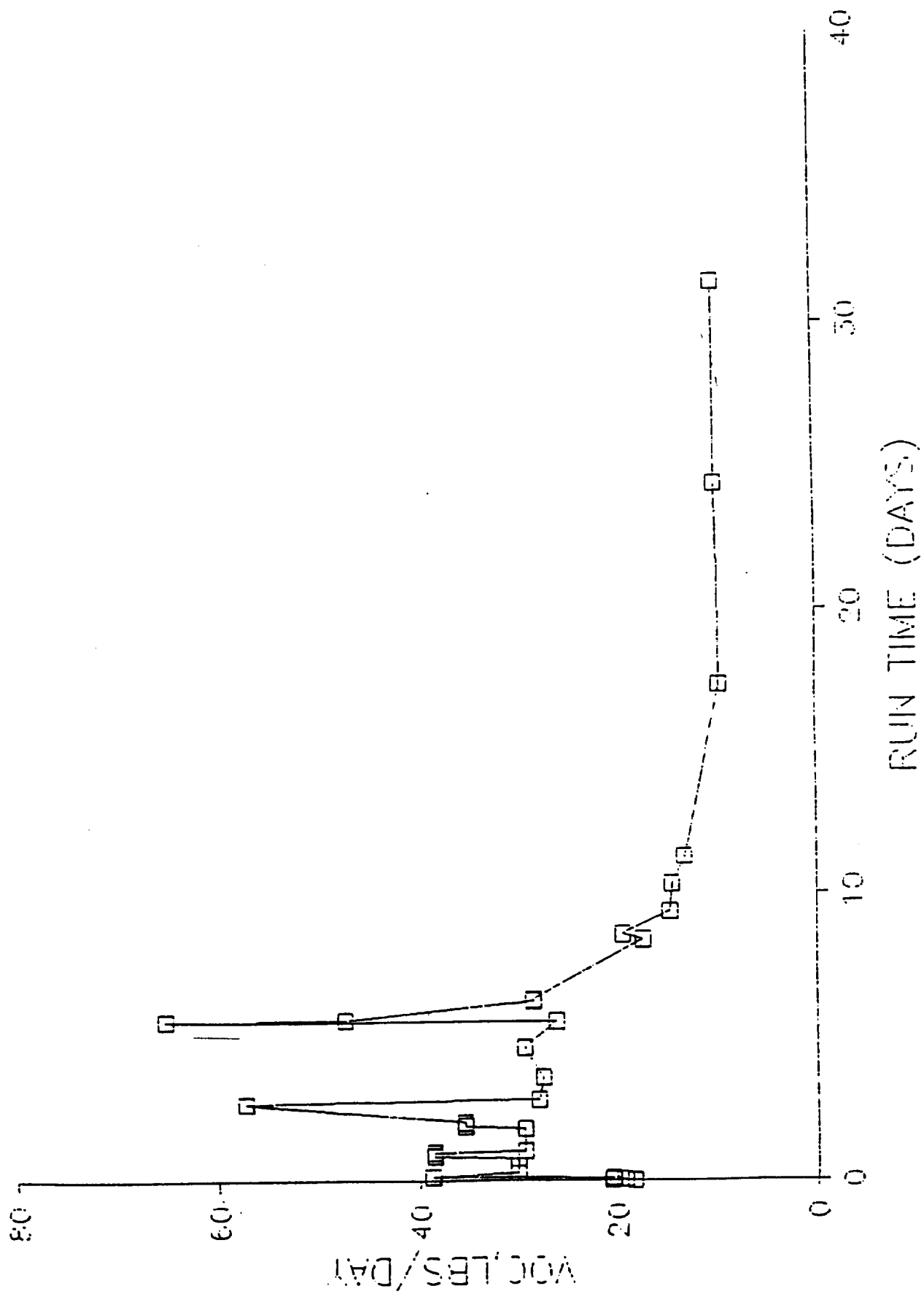


FIGURE 6

# HEW-2 INITIAL & FINAL RATES TERRA VAC HORIZONTAL EXTRACTION WELL

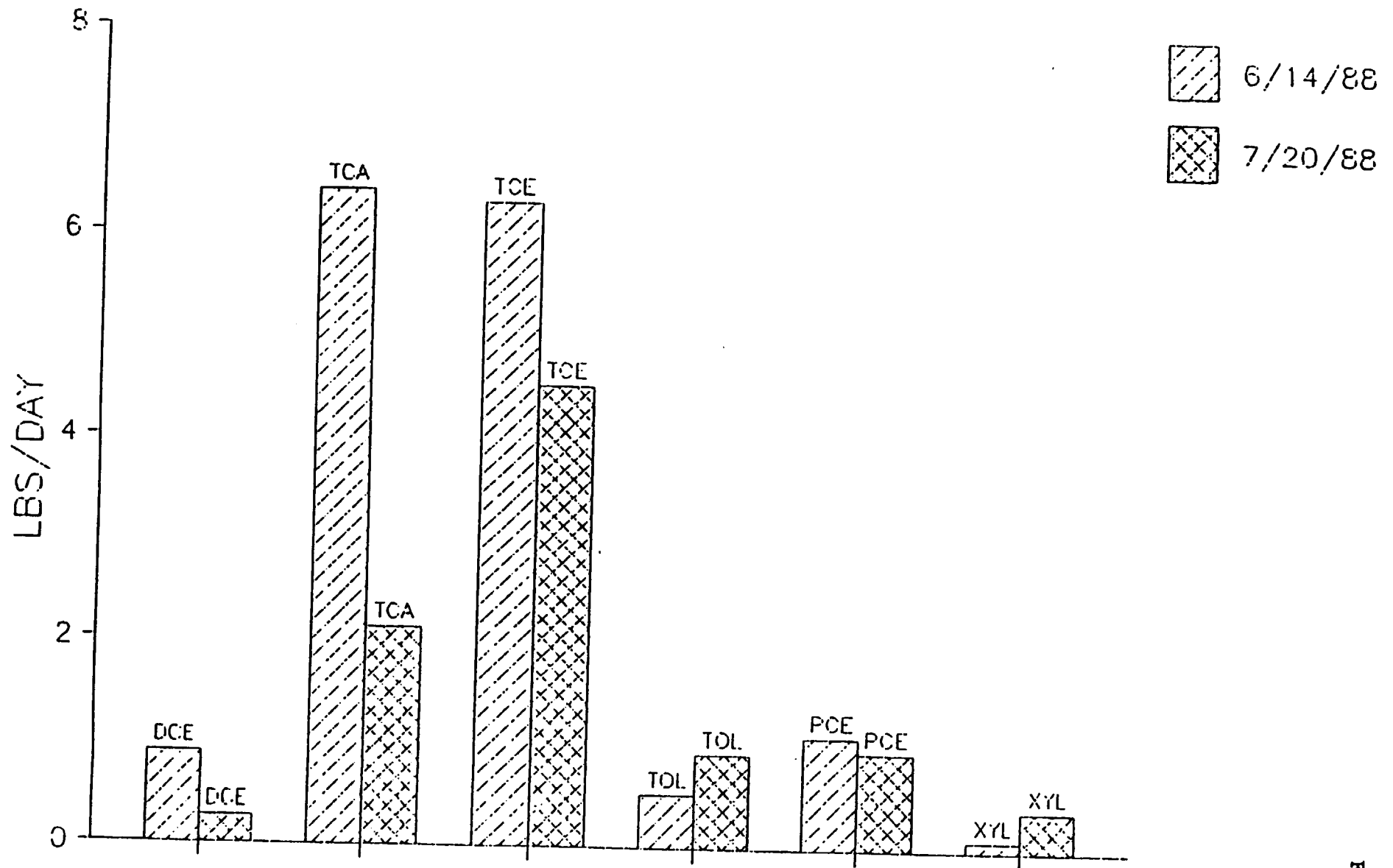


FIGURE 7



**APPENDIX A**

TERRA VAC/ ECC - ERH SITE / PROJECT 88-304

XX SUMMARY - ECC VACUUM EXTRACTION PILOT TEST													
XX													
SAMPLE TIME		X											
XX		RUN	X	FLOW	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUM
XX		TIME	X	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS MIN	XX	(DAYS)	X(SCFH)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17	XX	.00	X 0	0	0	0						0
14-Jun 12	18	XX	.00	X 4	.9	6.4	6.3	.5	1.1	.1	2.9	18.2	
14-Jun 12	38	XX	.01	X 4	.8	10.4	4.7	.7	.7	.1	3.0	20.5	
14-Jun 13	18	XX	.04	X 4	.9	10.3	4.3	.7	.9	.2	1.9	19.2	1
14-Jun 13	31	XX	.05	X 4									1
14-Jun 14	31	XX	.05	X 4									1
14-Jun 15	31	XX	.09	X 4	.7	11.5	4.7	.9	.9	.2	1.5	20.4	1
14-Jun 15	40	XX	.10	X 4									2
14-Jun 16	29	XX	.10	X 4									2
14-Jun 17	29	XX	.14	X 8	1.1	20.7	9.7	1.9	2.1	.6	2.7	38.7	2
14-Jun 20	42	XX	.28	X 8	.8	14.2	8.8	1.6	1.9	.5	2.1	30.1	7
15-Jun 8	39	XX	.77	X 17									22
15-Jun 9	20	XX	.77	X 17									22
15-Jun 11	30	XX	.86	X 17	1.0	15.5	13.4	2.2	3.0	.8	2.6	38.5	24
15-Jun 12	10	XX	.89	X 16								38.5	25
15-Jun 12	23	XX	.90	X 21	3.2	8.0	13.8	.3	1.4		.7	66.1	25
15-Jun 12	27	XX	.90	X 23	.8	2.9	1.5	.1	2.1		1.5	75.1	25
15-Jun 14	50	XX	1.00	X 38	1.3	9.4	5.3	1.0	4.1	.4	2.7	62.8	32
15-Jun 15	55	XX	1.05	X 41	.8	11.3	10.6	1.7	2.4	.5	2.1	53.6	35
15-Jun 16	2	XX	1.05	X 59								53.6	35
16-Jun 10	48	XX	1.83	X 79								53.6	77
16-Jun 13	6	XX	1.93	X 84	1.6	16.6	15.3	2.5	5.3	.8	3.4	45.5	82
16-Jun 15	45	XX	2.04	X 86								45.5	87
16-Jun 16	30	XX	2.07	X 98								45.5	88
16-Jun 19	15	XX	2.07	X 121									88
17-Jun 10	45	XX	2.72	X 191	2.9	23.5	24.4	3.2	8.6	1.0	12.3	75.9	113
17-Jun 11	0	XX	2.73	X 0	1.1	6.3	3.6	.5	3.4	1.0	12.3	75.9	114
17-Jun 11	40	XX	2.73	X 0									114
17-Jun 15	0	XX	2.87	X 202	.7	14.2	14.2	2.1	6.7	.6	3.4	41.9	116

A 2-

XX SUMMARY - ECC VACUUM EXTRACTION PILOT TEST													
XX													
SAMPLE TIME		XX	X										
		XX	RUN X FLOW	DCE	TCA	TCE	TOL	PCE	XYL	OTHER T.VOC	CUMH		
		XX	TIME X RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC	
DATE	HRS MIN	XX	(DAYS)X(SCFM)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#)	(LBS)
18-Jun	10 0	XX	3.66 X 240	1.2	12.1	13.7	2.1	6.0	.8	2.3	38.3	148	
19-Jun	10 30	XX	4.68 X 321	.9	12.8	14.8	2.1	6.9	.8	6.3	44.6	191	
19-Jun	10 47	XX	4.69 X 0	.4	5.4	2.6	.4	3.9	.8	6.3	44.6	191	
19-Jun	11 40	XX	4.69 X 0									191	
20-Jun	9 20	XX	5.59 X 210		5.6	10.5	1.6	2.6	.6	5.2	26.1	203	
20-Jun	9 50	XX	5.61 X 0						.6	5.2	26.1	203	
20-Jun	10 35	XX	5.61 X 0									203	
20-Jun	15 0	XX	5.61 X 141	.5	5.9	2.7	.4	4.9	.1	.5	15.1	205	
21-Jun	9 0	XX	5.61 X 185	.4	6.5	3.1	.5	5.7	.2	1.4	17.8	217	
21-Jun	9 33	XX	5.61 X 0								17.8	218	
21-Jun	10 30	XX	5.61 X 0									218	
22-Jun	10 0	XX	5.61 X 4	.1	.7	.9	.1	.1		.1	2.0	219	
22-Jun	16 10	XX	5.61 X 4	.1	.8	.9	.1	.2		.2	2.2	219	
23-Jun	10 0	XX	5.78 X 4	.1	1.1	1.1	.1	.2		.3	2.9	221	
24-Jun	11 0	XX	6.82 X 4		.3	.3				.1	.7	223	
24-Jun	14 30	XX	6.97 X 5		.3	.3				.1	.7	223	
24-Jun	16 34	XX	6.97 X 4									223	
24-Jun	16 50	XX	6.98 X 209	1.3	26.6	18.9	3.2	5.6	1.4	8.3	65.2	223	
24-Jun	17 35	XX	7.01 X 209	1.0	17.5	16.1	2.7	4.6	1.1	4.5	47.4	225	
25-Jun	9 15	XX	7.66 X 237	.6	7.0	10.9	1.6	2.5	.6	5.3	28.4	250	
25-Jun	10 30	XX	7.66 X 237	.6	7.0	10.9	1.6	2.5	.6	5.3	28.4	251	
27-Jun	11 30	XX	9.70 X 319	.4	3.8	8.1	1.6	1.8	.5	2.1	18.3	299	
27-Jun	11 45	XX	9.71 X 319	.4	3.4	7.8	1.5	1.8	.5	2.0	18.3	299	
27-Jun	16 0	XX	9.71 X 320	.4	3.3	8.0	1.6	1.8	.5	3.7	19.3	302	
28-Jun	10 35	XX	9.71 X 322	.3	2.8	6.7	1.4	1.6	.5	1.3	14.5	315	
29-Jun	10 0	XX	10.34X 324	.3	2.6	6.1	1.3	1.5	.5	2.1	14.3	330	
30-Jun	9 15	XX	11.31X 327	.3	2.4	5.6	1.1	1.3	.4	2.0	13.1	343	
06-Jul	11 0	XX	17.38X 362	.3	2.2	4.6	.8	.8	.3	.5	9.5	412	
13-Jul	11 0	XX	24.38X 347	.3	2.1	4.5	.9	1.0	.4	.7	9.9	479	
20-Jul	10 40	XX	31.37X 346								9.9	548	



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[illegible]

TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

XX													
XX HORIZONTAL EXTRACTION WELL - HEW-1													
XX													
SAMPLE TIME XX <<< OPERATING SUMMARY >>>													
XX RUN FLOW TOTAL DCE TCA TCE TOL PCE XYL OTHER T.VOC CUM													
XX TIME RATE VOC RATE RATE RATE RATE RATE RATE RATE RATE RATE RATE VOC													
DATE	HRS	MIN	XX	(DYS)	(SCFM)	(mg/l)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun 12	17	XX											
14-Jun 12	18	XX											
14-Jun 12	38	XX											
14-Jun 13	18	XX											
14-Jun 13	31	XX											
14-Jun 14	31	XX											
14-Jun 15	31	XX											
14-Jun 15	40	XX											
14-Jun 16	29	XX											
14-Jun 17	29	XX											
14-Jun 20	42	XX											
15-Jun 8	39	XX											
15-Jun 9	20	XX											
15-Jun 11	30	XX											
15-Jun 12	10	XX											
15-Jun 12	23	XX											.00
15-Jun 12	27	XX		2	58.74	.8	2.9	1.5	.1	2.1	1.47	8.9	
15-Jun 14	50	XX	.1	17	9.97	.9	5.2	2.3	.7	3.7	.3 1.70	14.8	1.2
15-Jun 15	55	XX	.1	17								14.8	1.9
15-Jun 16	2	XX	.2	25								14.8	1.9
16-Jun 10	48	XX	.9	33								14.8	13.5
16-Jun 13	6	XX	1.0	34	2.50	.5	2.8	1.2	.3	2.1	.1 .62	7.5	14.5
16-Jun 15	45	XX	1.1	34								7.5	15.4
16-Jun 16	30	XX	1.2	39								7.5	15.6
16-Jun 19	15	XX	1.2	52									15.6
17-Jun 10	45	XX	1.8	68	2.23	.8	4.6	1.9	.3	3.0	.1 3.00	13.6	20.0
17-Jun 11	0	XX	1.8		2.23	.8	4.6	1.9	.3	3.0	.1 3.00	13.6	20.1
17-Jun 11	40	XX	1.8										20.1
17-Jun 15	0	XX	2.0	82	1.78	.7	4.9	2.0	.4	3.6	.2 1.44	13.1	21.0

4.

[illegible]

TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

XX														
XX VERTICAL EXTRACTION WELL - VE-1														
VE-1														
XX														
SAMPLE TIME		XX	<<< OPERATING SUMMARY >>>											
		XX	RUN	FLOW	TOTAL	DCE	TCA	TCE	TOL	PCE	XYL	OTHER	T.VOC	CUM
		XX	TIME	RATE	VOC	RATE	RATE	RATE	RATE	RATE	RATE	RATE	RATE	VOC
DATE	HRS	MIN	XX	(DYS)	(SCFH)	(mg/l)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(#/DY)	(LBS)
14-Jun	12	17	XX											
14-Jun	12	18	XX											
14-Jun	12	38	XX											
14-Jun	13	18	XX											
14-Jun	13	31	XX											
14-Jun	14	31	XX											
14-Jun	15	31	XX											
14-Jun	15	40	XX											
14-Jun	16	29	XX											
14-Jun	17	29	XX											
14-Jun	20	42	XX											
15-Jun	8	39	XX											.00
15-Jun	9	20	XX											
15-Jun	11	30	XX											
15-Jun	12	10	XX											
15-Jun	12	23	XX			4	73.67	3.2	8.0	13.8	.3	1.4	.7	27.6 .1
15-Jun	12	27	XX			4								27.6 .2
15-Jun	14	50	XX	.1		4	25.36	.4	4.2	3.0	.4	.4	.1 1.0	9.5 2.0
15-Jun	15	55	XX	.2		8								9.5 2.5
15-Jun	16	2	XX	.2		8								9.5 2.5
16-Jun	10	48	XX	.9		13								9.5 10.0
16-Jun	13	6	XX	1.0		13	2.18	.1	1.0	.5	.3	.1	.5	2.5 10.5
16-Jun	15	45	XX	1.1		15								2.5 10.8
16-Jun	16	30	XX	1.2		15								2.5 10.9
16-Jun	19	15	XX	1.2		15								10.9
17-Jun	10	45	XX	1.8		17	3.31	.3	1.7	1.7	.3	.3	.1 .5	5.0 12.5
17-Jun	11	0	XX	1.8			3.31	.3	1.7	1.7	.3	.3	.1 .5	5.0 12.5
17-Jun	11	40	XX	1.8										12.5
17-Jun	15	0	XX	2.0		4	2.53	.1	.4	.2	.1		.1 .9	12.6





**APPENDIX B**

TEEEA VAC/ RCC - ERN SITE / PROJECT 88-304

----- XX -----																							
XX HORIZONTAL EXTRACTION WELL - REV-2												REV-2											
----- XX -----																							
SAMPLE TIME		XX	(( OPERATION DATA ))					(( GAS CHROMATOGRAPH READOUT ))								(( WELLEAD CONCENTRATION ))							
		XX	INJ	WELL	FLOW	FLOW		1.1	1.1.1		K.P-	TOTAL		1.1	1.1.1		K.P-						
		XX	SAMP	VOL	VAC	RATE	RATE		DCE	TCA	TCZ	TOL	PCE	ITL	AREA		DCE	TCA	TCZ	TOL	PCE	ITL	OTHER
DATE	HRS	MIN	XX	NUM	(ml)	(°Hg)(SCFM)	(ACFM)		(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	1000X		(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)
=====																							
14-Jun	12	17	XX	777											0								
14-Jun	12	18	XX	106	100	10.0	4	5	.163	1.170	1.150	.094	.200	.019	1020		2.445	17.55	17.25	1.410	3.000	.265	7.92
14-Jun	12	38	XX	107	100	10.0	4	5	.146	1.850	.863	.121	.109	.024	1105		2.190	28.35	12.95	1.815	1.955	.360	8.27
14-Jun	13	18	XX	108	100	10.0	4	5	.162	1.870	.791	.129	.132	.031	930		2.450	28.05	11.87	1.935	2.445	.465	5.31
14-Jun	13	31	XX	999	100	10.0	4	5															
14-Jun	14	31	XX	777	100	10.0	4	5															
14-Jun	15	31	XX	109	100	7.5	4	5	.128	2.216	.903	.171	.131	.048	990		1.707	29.55	12.04	2.250	2.587	.640	3.94
14-Jun	15	40	XX	999	100	8.0	4	5															
14-Jun	16	29	XX	777	100	9.0	4	5															
14-Jun	17	29	XX	110	100	8.5	8	10	.103	1.953	.915	.182	.138	.057	928		1.437	27.25	12.77	2.540	2.721	.755	3.55
14-Jun	20	42	XX	111	100	9.0	8	10	.077	1.328	.823	.152	.150	.051	728		1.100	18.97	11.76	2.171	2.586	.729	2.78
15-Jun	8	39	XX	999	100	9.3	17	20															
15-Jun	9	20	XX	777	100	9.0	17	20															
15-Jun	11	30	XX	112	100	9.0	17	20	.046	.724	.626	.104	.104	.036	475		.657	10.34	8.94	1.486	2.000	.514	1.76
15-Jun	12	10	XX	888	100	10.0	16	20															
15-Jun	12	23	XX	888	100	10.0	16	20															
15-Jun	12	27	XX	888	100	9.0	17	20															
15-Jun	14	50	XX	888	100	8.5	17	20															
15-Jun	15	55	XX	117	100	9.5	17	20	.036	.520	.451	.077	.084	.025	358		.527	7.610	7.195	1.127	1.555	.366	1.39
15-Jun	16	2	XX	888	100	8.5	25	30															
16-Jun	10	48	XX	888	100	9.0	33	40															
16-Jun	13	6	XX	120	100	9.1	38	45	.020	.266	.283	.042	.051	.012	191		.287	3.816	4.062	.603	.904	.172	.68
16-Jun	15	45	XX	888	100	9.0	38	45															
16-Jun	16	30	XX	999	100	1.0	44	45															
16-Jun	19	15	XX	777	100	12.0	54	70															
17-Jun	10	45	XX	125	100	7.8	106	123	.014	.134	.162	.021	.034	.007	143		.189	1.811	2.189	.284	.554	.095	.93
17-Jun	11	0	XX	999	100	1.0	0																
17-Jun	11	40	XX	777	100	1.0	0																
17-Jun	15	0	XX	129	100	9.0	115	138	ND	.060	.081	.011	.018	.003	50		.857	1.157	.157	.300	.043	.18	

TERRA VIC/ ECC - EEN SITE / PROJECT 88-304

[illegible]

TERRA VAC/ ECC - ERM SITE / PROJECT 88-304

----- XX -----																					
XX HORIZONTAL EXTRACTION WELL - EEV-1										EEV-1					EEV-1						
----- XX -----																					
SAMPLE TIME	XX (( OPERATION DATA ))								XX (( GAS CHROMATOGRAPH READOUT ))								XX (( WELLHEAD CONCENTRATION ))				
XX TBJ WELL FLOW FLOW										XX 1.1 1.1.1								XX 1.1 1.1.1			
XX SAMP VOL VAC RATE RATE										XX DCE TCA TCE TOL PCE IYL AREA								XX DCE TCA TCE TOL PCE IYL OTHER			
DATE	ERS	MIN	XX	NUM	(ul)	(°Eq)	(SCFH)	(ACFH)		((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	((ng/l))	1000X	((ng/l))	((ng/l))	((ng/l))	((ng/l))	
=====																					
14-Jun 12	17		XX																		
14-Jun 12	18		XX	100	1.0																
14-Jun 12	38		XX	100	1.0																
14-Jun 13	18		XX	100	1.0																
14-Jun 13	31		XX	100	1.0																
14-Jun 14	31		XX	100	1.0																
14-Jun 15	31		XX	100	1.0																
14-Jun 15	40		XX	100	1.0																
14-Jun 16	29		XX	100	1.0																
14-Jun 17	29		XX	100	1.0																
14-Jun 20	42		XX	100	1.0																
15-Jun 8	39		XX	100	1.0																
15-Jun 9	20		XX	100	1.0																
15-Jun 11	30		XX	100	1.0																
15-Jun 12	10		XX	100	1.0																
15-Jun 12	23		XX	777	100	1.0															
15-Jun 12	27		XX	114	100	8.5	2	2		.377	1.360	.701	.034	1.015	.008	1210	5.26	19.26	9.78	.47	
15-Jun 14	50		XX	115	100	9.5	17	20		.040	.241	.107	.030	.170	.015	194	.59	3.53	1.57	.44	
15-Jun 15	55		XX	666	100	9.5	17	20													
15-Jun 16	2		XX	888	100	9.5	25	30													
16-Jun 10	48		XX	666	100	9.5	33	40													
16-Jun 13	6		XX	122	100	8.8	34	40		.012	.065	.027	.006	.049	.003	44	.17	.92	.38	.08	
16-Jun 15	45		XX	666	100	8.8	34	40													
16-Jun 16	30		XX	999	100	1.0	39	40													
16-Jun 19	15		XX	777	100	1.0	52	53													
17-Jun 10	45		XX	124	100	8.4	66	80		.609	.054	.022	.003	.036	.001	54	.13	.75	.31	.04	
17-Jun 11	0		XX	999	100	1.0															
17-Jun 11	40		XX	777	100	1.0															
17-Jun 15	0		XX	127	500	9.7	82	100		.031	.227	.090	.018	.163	.007	158	.09	.67	.27	.05	

## TERRA PAC/ ECC - ERM SITE / PROJECT 88-304

[illegible]

VEERA VAC/ ECC - ERM SITE / PROJECT 88 - 304

----- IX -----																						
IX VERTICAL EXTRACTION WELL - VE-1											VERTICAL EXTRACTION WELL - VE-1											
----- IX -----																						
SAMPLE TIME		(( OPERATION DATA ))					(( GAS CHROMATOGRAPH READOUT ))								(( WELLHEAD CONCENTRATION ))							
		INJ WELL FLOW FLOW					M,P- TOTAL								M,P-							
		SIKE	VOL	VAC	RATE	RATE	DCE	TCA	PCE	TOL	PCE	ITL	AREA	DCE	TCA	PCE	TOL	PCE	ITL	OTHER		
DATE	RES MIN	IX	NUM	(ml)	("Hg)	(SCFH)	(ACFH)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	1000X	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	(ng/l)	
=====																						
14-Jun 12	17	IX												0								
14-Jun 12	18	IX		100	1.0									0								
14-Jun 12	38	IX		100	1.0									0								
14-Jun 13	16	IX		100	1.0									0								
14-Jun 13	31	IX		100	1.0									0								
14-Jun 14	31	IX		100	1.0									0								
14-Jun 15	31	IX		100	1.0									0								
14-Jun 15	40	IX		100	1.0									0								
14-Jun 16	29	IX		100	1.0									0								
14-Jun 17	29	IX		100	1.0									0								
14-Jun 20	42	IX		100	1.0									0								
15-Jun 8	39	IX		100	1.0									0								
15-Jun 9	20	IX		100	1.0									0								
15-Jun 11	30	IX		100	1.0									0								
15-Jun 12	10	IX	777	100	8.8									0								
15-Jun 12	23	IX	113	100	9.0	4	511	.606	1.501	2.584	.059	.267	.007	1049	11	8.657	21.44	36.91	.843	3.814	.100	1.29
15-Jun 12	27	IX	688	100	8.8	4	511															
15-Jun 14	50	IX	116	100	9.0	4	511	.078	.782	.558	.072	.082	.020	450	11	1.114	11.17	7.97	1.029	1.171	.286	2.62
15-Jun 15	55	IX	686	100	9.0	8	1011															
15-Jun 16	2	IX	686	100	9.0	8	1011															
16-Jun 10	48	IX	628	100	8.5	13	1511															
16-Jun 13	6	IX	121	100	8.0	13	1511	.008	.065	.030	.016	.008	.003	61	11	.109	.89	.41	.216	.109	.041	.40
16-Jun 15	45	IX	688	100	1.0	15	1511															
16-Jun 16	30	IX	999	100	1.0	15	1511															
16-Jun 19	15	IX	777	100	1.0	15	1511															
17-Jun 10	45	IX	126	100	8.6	17	2011	.016	.081	.082	.012	.015	.003	68	11	.226	1.15	1.16	.170	.212	.042	.36
17-Jun 11	0	IX	999	100	1.0																	
17-Jun 11	40	IX	777	100	1.0																	
17-Jun 15	0	IX	128	500	10.0	4	511	.053	.339	.213	.070	.041	.017	280	11	.159	1.02	.64	.210	.123	.051	.33

[illegible]



**ATTACHMENT 1**

## TERRA VAC CORPORATION

Project 88-304

Gas Chromatograph ParametersI. SCOPE

In order to accurately quantitate Volatile Organic Compound (VOC) content it is necessary to insure peak separation. This is achieved by the use of an appropriate column, with the aid of a temperature program. The parameters for this program are set forth here.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Temperature programmable gas chromatograph (Shimadzu GC-9A) equipped with a flame ionization detector (FID) and a wide bore capillary column.
3. Nitrogen, carrier gas, zero grade or better
4. Hydrogen, combustion gas, zero grade or better
5. Air, combustion gas, zero grade or better

III. PARAMETERS

1. Initial temperature, 40 C
2. Initial hold, 2 minutes
3. Program rate, 5 C/minute
4. Intermediate temperature, 85 C
5. Intermediate hold, 0.5 minutes
6. Secondary ramp rate, 15 C/minute
7. Final temperature, 150 C
8. Final hold, 3 minutes
9. Inlet temperature, 150 C
10. Carrier gas flow, 20 ml/minute
11. Combustion gas flow, Air, 350 ml/minute
12. Combustion gas flow, Hydrogen, 55 ml/minute
13. Detector range, 10<sup>-1</sup>

IV. PRECAUTIONS

Do not exceed temperature limit of column. Do not operate oven without oven fan operating. Periodically check and clean air filter to electronics. Technician must be fully trained before attempting to operate the gas chromatograph.

**ATTACHMENT 2**

TERRA VAC CORPORATION

Project 88-304

Integrator Parameters

I. SCOPE

The parameters stated here are normal operating parameters for use with a flame ionization detector (FID). These parameters will require periodic optimization by the operator in order to achieve maximum sensitivity.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Integrator (Shimadzu C-R3A)

III. PARAMETERS

1. Zero = 0
2. Attenuation (ATTN 2 ) = 4
3. Chart speed (CHT SP) = 10 mm/min.
4. Area reject (AR REJ) = 250
5. Slope = 300

IV. PRECAUTIONS

It is important that the operator has a full understanding of the instrument in order to achieve optimization. If in doubt about any procedure, refer to the operation manual.

**ATTACHMENT 3**

TERRA VAC CORPORATION

Project 88-304

Sampling Techniques of Volatile Organic Compounds

I. SCOPE

Volatile Organic Compounds (VOC) are regulated, toxic chemicals and should be treated with care to avoid personal and environmental contamination.

When sampling vapors from the vacuum system it will be considered that the air stream is contaminated with VOC's.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Hamilton Gastight Syringes 1000ul, 500ul, 250ul sizes

III. PROCEDURE

1. Purge syringe with clean air
2. Insert syringe into well head septum
3. Purge syringe with air stream to be sampled
4. Draw plunger back to desired volume
5. Withdraw needle from wellhead septum and stopper with a septum
6. Log time, location, wellhead vacuum and flow then return sample to GC

IV. PRECAUTIONS

Test syringe before use for leaking plunger and tight needle.

**ATTACHMENT 4**



## TERRA VAC CORPORATION

Project 88-304

Volatile Organic Compounds StandardI. SCOPE

The purpose of this procedure is to define the standardization of the gas chromatograph for reference in the quantitative analysis of samples containing unknown amounts of Volatile Organic Compounds.

II. EQUIPMENT AND REAGENTS

1. Clean and well lighted work area
2. Gastight syringes 1000ul, 250ul, 100ul.
3. Pure compounds (CAUTION: Some VOC's are known carcinogens and should be handled with care to avoid possible contamination.)
4. Gas sampling bulb 1000ml size

III. PROCEDURESCalibration using pure VOC to make gas standard

1. Run a blank of the syringe and 1 liter gas sampling bulb to be used.
2. Inject a known volume of the liquid VOC (or of an equal volume mixture of several compounds of interest) into the 1 liter bulb (verify actual bulb volume beforehand). This is on the order of 1 ul for 100 to 300 ppm levels.
3. Allow the liquid to vaporize and disperse throughout the bulb. This may take 5-10 minutes depending on volatility of the compounds. See precautions.
4. Using a gastight syringe, withdraw a 100-1000ul sample from the bulb and inject it into the GC. Volume utilized should approximate expected field concentrations.
5. Calculation of concentration:

$$\text{mg/L} = \frac{\text{sp.gravity} * \text{liq.vol} * \% \text{purity} * \text{inj.volume (ul)}}{\text{bulb volume} * 100\% * 1000\text{ul}}$$

6. If not within 10% of previous calibration, repeat 4&5. Otherwise maintain calibration values established.
7. Calibrate to new values when repeatability is shown. See precautions.

#### IV PRECAUTIONS

1. In injecting headspace vapor from pure compound, care must be taken not to overload the column.
2. A wide change in calibration values indicates that troubleshooting of the system or procedures is necessary.
3. In using a liquid, be sure the volume injected will be well below vapor saturation for the bulb volume used.
4. Examine the bulb for any droplets or condensation that may indicate incomplete vaporization of the liquid. Some warming of the bulb (i.e., sunlight, rubbing with a cloth, even the GC oven briefly) may hasten the process. The less volatile the compound, the more problem this becomes.
5. Do not rely on the bulb's integrity for more than an hour.

**APPENDIX B**

**ECC REMEDIAL ACTION PLAN  
ESTIMATION OF WATER VOLUMES COLLECTED  
IN THE GROUND WATER INTERCEPTION TRENCH**

## APPENDIX B

### ECC REMEDIAL ACTION PLAN ESTIMATION OF WATER VOLUMES COLLECTED IN THE GROUND WATER INTERCEPTION TRENCH

Following the procedure in Appendix B of the FS:

$$Q_t = Q_r + Q_i + Q_{rec}$$

where:

$Q_t$  = total water flow to the trench, gpm

$Q_r$  = regional ground water flow to the trench, gpm

$Q_i$  = flow induced due to the presence of the trench, gpm

$Q_{rec}$  = recharge flow, due to precipitation and upward recharge from the sand and gravel unit, gpm

$$Q_r = K_r \cdot A_r \cdot i_r$$

where:

$K_r$  = permeability of till =  $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup> (section 5 of RI)

$d$  = depth of trench, assume 10 ft

$A_r$  = area of trench in the direction of ground water flow, ft<sup>2</sup> =  $L \times d$

$L$  = length of trench, 330 ft

$i_r$  = regional gradient = 0.05 ft/ft south of the site (Appendix B of FS)

$$Q_i = K_i \cdot i_I \cdot A_i$$

where:

$K_i$  = permeability of till =  $10^{-5}$  cm/s - 0.212 gal/d.ft<sup>2</sup> (Section 5 of RI)

$i_i$  = gradient induced due to drain -  $h/l$

$h$  = height of water table above the drain centers  
=  $1/2$  maximum depth = 5 ft

$l$  =  $z/2$  = 20 ft

$z$  = zone of influence of trench in the perpendicular direction, 40 ft

$A_i$  = area of induced flow =  $L \times h$

$$Q_{rec} = (W_p + W_v) A_{rec}$$

where:

$W_p$  = recharge due to precipitation, assumed to be  
7.8 in/yr = 0.013 gal/d.ft<sup>2</sup> (Appendix B of FS)

$W_v$  = recharge due to upward movement from the sand and gravel unit =  $k_v \times i_v$

$k_v$  = vertical permeability of till assumed to be  
 $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup>

$i_v$  = vertical gradient = 0.25 ft/ft = 3 ft difference in head over 12 ft of thickness of shallow saturated zone (Appendix B of FS)

$A_{rec}$  = recharge area, ft<sup>2</sup> -  $L \times Z$

For the trench to be installed at ECC =

$$\begin{aligned} Q_r &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 10 \text{ ft} \times 0.05 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.03 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_i &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 5 \text{ ft} \times 0.25 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.06 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_{rec} &= 0.013 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 1 \text{ d/1440 min} \\ &\quad + 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 0.25 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.61 \text{ gpm} \end{aligned}$$

$$Q_t = 0.03 + 0.06 + 0.61 = 0.70 \text{ gpm}$$

**APPENDIX B**

**DETERMINATION OF END POINT FOR VAPOR EXTRACTION**

## APPENDIX B

### DETERMINATION OF END POINT FOR VAPOR EXTRACTION

The procedure consists of: (1) calculating the remaining soil concentration using the vapor concentrations; and (2) evaluating whether the concentrations of VOCs in soils are above acceptable levels by using the analysis results from water samples collected from individual trenches. An example is shown below.

#### 1. Concentrations in Soils Based on Vapor Concentration

The concentration of VOCs in the extracted vapors can be related to the concentration in the soil through Henry's Law and the soil-water partition coefficient, on the basis that within the soil matrix, soil particles, moisture and soil vapor are in equilibrium.

The concentration of a VOC in soil moisture which is in equilibrium with soil particles can be estimated by the equation (Superfund Public Health Evaluation Manual, EPA, October, 1986):

$$C_w = k_d \cdot C_s$$

Where:

$C_w$  = concentration of VOC in soil moisture, ug/l

$k_d$  = soil-water partition coefficient, l/Kg

$C_s$  = soil concentration of VOC, ug/Kg

The soil vapor VOC concentration in equilibrium with the soil moisture can be calculated using Henry's Law:

$$C_v = H \cdot C_w$$

Where:

$C_v$  = soil vapor VOC concentration,  $\text{mg}/\text{m}^3$

$H$  = nondimensional Henry's Law constant

To account for the differences in soil concentrations, it will be assumed that, as vapor extraction proceeds, the VOC concentrations in the soils will follow the same distribution as currently present in the soil. To determine the acceptable average soil concentration, the following equation will be used:

$$C_{s,avg} = C_{s,acc} \cdot C_{s,50}/C_{s,95}$$

Where:

$C_{s,avg}$  = acceptable average soil concentration,  $\text{ug}/\text{Kg}$

$C_{s,acc}$  = acceptable soil concentration,  $\text{ug}/\text{Kg}$

$C_{s,50}$  = value which represents a 50% probability that the samples collected on-site had concentrations less than or equal to this value,  $\text{ug}/\text{Kg}$

$C_{s,95}$  = value which represents a 95% probability that the samples collected on-site had concentrations less than or equal to this value,  $\text{ug}/\text{Kg}$

The shut-off vapor concentration will be calculated as:

$$C_{v,off} = H \cdot K_d \cdot C_{s,acc} \cdot C_{s,50}/C_{s,95}$$

The vapor extraction system will be operated until vapor concentrations are reduced to the shut-off levels. For example, the shut-off vapor concentration for TCE is  $0.0363 \text{ mg}/\text{m}^3$ , calculated using the following data:



H	= 0.378	Superfund Public Health Eval. Manual, October, 1986
k <sub>d</sub>	= 0.24	Table 5-3 of ECC RI
C <sub>s,50</sub>	= 15 ug/Kg	Table B-1 attached
C <sub>s,95</sub>	= 150,000 ug/Kg	Table B-1 attached
C <sub>s,acc</sub>	= 4000 ug/Kg	Appendix C-1 of ECC RI

If a TCE vapor concentration of 0.1 mg/m<sup>3</sup> is detected, the corresponding soil concentration would be:

$$\begin{aligned}
 C_s &= C_v \cdot C_{s,95} / (C_{s,50} \cdot H \cdot k_d) \\
 C_s &= (0.1 \text{ mg/m}^3) \times (150,000 \text{ ug/Kg}) / ((15 \text{ ug/Kg}) \times \\
 &\quad (0.378) \times (0.24)) \\
 &= 11,020 \text{ ug/Kg}
 \end{aligned}$$

## 2. Concentration in Soils Based on Water Concentrations

It is assumed that a sample of water from one of the sampling ports in the water manifold of the vapor extraction system had a TCE concentration of 1200 ug/l.

The trench is 150 feet long. Assuming that only 10 feet of trench receive water from soils with TCE concentrations higher than the acceptable 4000 ug/Kg level, the actual concentration of TCE in the water is (1200 ug/l) x (150 ft/10 ft) = 18,000 ug/l. This water can be assumed to be in equilibrium with the soil concentrations, due to the slow ground water travel velocity in the fill.

From the ECC RI, Table 5-3, the soil-water partition coefficient is k<sub>d</sub> = 0.24. The soil concentration in equilibrium with the collected water is:

$$\begin{aligned}
 C_s &= C_w k_d \\
 &= (18,000 \text{ ug/l}) \times (0.24) = 4320 \text{ ug/Kg}
 \end{aligned}$$

Therefore, the TCE soil concentration in this area is above acceptable levels, and vapor extraction operations must be continued.

**TABLE B-1**  
**DISTRIBUTION OF TCE SAMPLING RESULTS**

<u>Location</u>	<u>Depth</u>	<u>Concentration (ug/Kg)</u>	<u>Rank</u>	<u>Probability of Occurrence (%)</u>
TP-1	1-1.5	ND	1	2.78
TP-2	1-1.5	ND	2	5.56
TP-5	2-3	ND	3	8.33
TP-6	2-3	ND	4	11.11
TP-11	1-3	ND	5	13.89
TP-1	4-5	ND	6	16.67
TP-4	2.5-3.5	ND	7	19.44
TP-6	4-5	ND	8	22.22
TP-11	3-5	ND	9	25.00
SB-04	2-3.5	ND	10	27.78
SBO104	5.5-7	ND	11	30.56
SBO204	5.5-7	ND	12	33.33
SBO403	5-6.5	ND	13	36.11
SBO805	7-8.5	3J	14	38.89
TP-10	3-5	6	15	41.67
TP-9	3-5	13	16	44.44
TP-8	1-2.5	14	17	47.22
TP-10	1-3	15	18	50.00
SB-08	2.5-4	16J	19	52.78
SB-01	2.5-4	39	20	55.56
SBO904	5.7-7	76	21	58.33
TP-12	3-5	86	22	61.11
TP-4	1-2	280B	23	63.89
SB-03	2.5-4	340	24	66.67
TP-12	1-3	410	25	69.44
TP-5	1-2	580	26	72.22
SB-09	2.5-4	640	27	75.00
TP-7	2.5-4	1800	28	77.78
TP-3	1-1.5	3400B	29	80.56
TP-7	1-2.5	6000	30	83.33
TP-8	2.5-4	66,000	31	86.11
SB-02	2.5-4	68,000	32	88.89
SB-06	2-3.5	110,000	33	91.67
TP-9	1-3	150,000	34	94.44
TP-6	1-2	4,800,000B	35	97.22

Probability of Occurrence = rank/(total number of samples +1)

ND: Not detected

B : Analyte has been found in the laboratory blank as well as in the sample. Indicates probable contamination.

J : Indicates an estimated value. When mass spectral data indicates the presence of a compound that meets the identification criteria and the result is less than the specified detection limit but greater than zero.

## **APPENDIX C**

### **ESTIMATION OF WATER VOLUMES COLLECTED IN THE GROUND WATER INTERCEPTION TRENCH**

## APPENDIX C

### ESTIMATION OF WATER VOLUMES COLLECTED IN THE GROUND WATER INTERCEPTION TRENCH

Following the procedure in Appendix B of the FS:

$$Q_t = Q_r + Q_i + Q_{rec}$$

where:

$Q_t$  = total water flow to the trench, gpm

$Q_r$  = regional ground water flow to the trench, gpm

$Q_i$  = flow induced due to the presence of the trench, gpm

$Q_{rec}$  = recharge flow, due to precipitation and upward recharge from the sand and gravel unit, gpm

$$Q_r = K_r \cdot A_r \cdot i_r$$

where:

$K_r$  = permeability of till =  $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup> (section 5 of RI)

$d$  = depth of trench, assume 10 ft

$A_r$  = area of trench in the direction of ground water flow, ft<sup>2</sup> =  $L \times d$

$L$  = length of trench, 330 ft

$i_r$  = regional gradient = 0.05 ft/ft south of the site (Appendix B of FS)

$$Q_i = K_i \cdot i_I \cdot A_i$$

where:

$K_i$  = permeability of till =  $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup> (Section 5 of RI)

$i_i$  = gradient induced due to drain -  $h/l$

$h$  = height of water table above the drain centers  
=  $1/2$  maximum depth = 5 ft

$l$  =  $z/2$  = 20 ft

$z$  = zone of influence of trench in the perpendicular direction, 40 ft

$A_i$  = area of induced flow =  $L \times h$

$$Q_{rec} = (W_p + W_v) A_{rec}$$

where:

$W_p$  = recharge due to precipitation, assumed to be  
7.8 in/yr = 0.013 gal/d.ft<sup>2</sup> (Appendix B of FS)

$W_v$  = recharge due to upward movement from the sand and gravel unit =  $k_v \times i_v$

$k_v$  = vertical permeability of till assumed to be  
 $10^{-5}$  cm/s = 0.212 gal/d.ft<sup>2</sup>

$i_v$  = vertical gradient = 0.25 ft/ft = 3 ft difference in head over 12 ft of thickness of shallow saturated zone (Appendix B of FS)

$A_{rec}$  = recharge area, ft<sup>2</sup> -  $L \times Z$

For the trench to be installed at ECC =

$$\begin{aligned} Q_r &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 10 \text{ ft} \times 0.05 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.03 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_i &= 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 5 \text{ ft} \times 0.25 \text{ ft/ft} \\ &\quad \times 1 \text{ d/1440 min} \\ &= 0.06 \text{ gpm} \end{aligned}$$

$$\begin{aligned} Q_{rec} &= 0.013 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 1 \text{ d/1440 min} \\ &\quad + 0.212 \text{ gal/d.ft}^2 \times 330 \text{ ft} \times 40 \text{ ft} \times 0.25 \text{ ft/ft} \times 1 \text{ d/1440 min} \\ &= 0.61 \text{ gpm} \end{aligned}$$

$$Q_t = 0.03 + 0.06 + 0.61 = 0.70 \text{ gpm}$$



**ERM-North Central, Inc.**

Environmental Resources Management

102 Wilmot Road • Suite 300 • Deerfield, Illinois 60015 ☎ (312) 940-7200

December 8, 1988

Ms. Karen Vendl  
U.S. Environmental Protection Agency  
Region V (5HE-12)  
230 South Dearborn Street  
Chicago, Illinois 60604

Re: ECC Site Remediation Plans

Dear Karen:

At the request of the ECC Settlers Steering Committee and Technical Committee, the enclosed materials are provided for your information. This material is the conceptual plan for the documents which are being prepared regarding the ECC site remediation.

If you have any questions, please call.

Very truly yours,

ERM-NORTH CENTRAL, INC.

A handwritten signature in black ink, appearing to be 'J. Imse', written over the printed name.

John P. Imse  
Senior Geologist

rms  
enclosures

cc: Al Sloan, CH2M-Hill  
John Buck, Indiana Department of Environmental Management  
D. Smith, Pratt & Lambert  
J. Amber, Ford Motor Company  
N. Bernstein, Jenner & Block  
T. Harker, The Harker Firm  
J. Kyle, Barnes & Thornburg  
K. Johnson, Metal Working Lubricants

## **PROJECT SCHEDULE**

The Remedial Design (RD) activities will consist of preparing a document package that will include the implementation plans and specifications for this remedial action.

### **Remedial Design Report Overview**

Table 1 presents an outline of the contents of the RD report. The specific requirements of each major heading are described below.

#### **Introduction**

This section will present the objectives of the RD, as well as the project background.

#### **Site Description**

The site conditions will be described as they relate to the design activities. This will include location, climate, topography and drainage, geological and hydrogeological setting, surface structures and concentrations of compounds.

#### **Design Criteria**

The specific requirements for design of the Remedial Action (RA) will be described in this section, including the remediation goals, performance criteria and engineering requirements.

#### **Engineering Analyses**

This section will describe the calculations performed to design the RA to meet the design criteria. All design considerations will be presented, including sizing of pipelines, selection of



blower, stability of trenches, rate of volatile organic compounds (VOCs) removal, etc.

#### **Remedial Action Construction Requirements**

Construction requirements include the final plans and specifications, the Quality Assurance Project Plan (QAPP), and the Health and Safety Specifications. The final plans and specifications will have been proofread, edited and cross-checked to ensure that the bid form, specifications and drawings are consistent with each other.

The QAPP will identify the project organization and responsibilities for quality control and quality assurance.

The Health and Safety Specifications will be detailed to allow the RA contractor to prepare a site-specific Health and Safety Plan that will ensure protection of the on-site personnel from any site hazards. The Health and Safety Specifications will present the minimum requirements for a Health and Safety Plan to comply with all applicable laws and regulations. Table 2 lists the references to be used in preparing the Health and Safety Plan.

#### **Operation and Maintenance Requirements**

The Operation and Maintenance Plan will include the basic elements shown in Table 3. Normal and emergency operation procedures, maintenance activities, schedule of operation and maintenance, monitoring required, records, and annual budget will be described in this plan.

## **Post-Remedial Action Construction Requirements**

This section will present the procedure to evaluate and report the RA performance through: (1) ground and surface water monitoring; and (2) vapor extraction system water and vapor monitoring. Also, the specifications for equipment start-up and operator training will be detailed.

## **Estimated Remedial Action Schedule**

The RD will include a schedule for implementing the plans and specifications as prepared.

## **Remedial Design Tasks**

The RD tasks include:

- o Design preparation;
- o Preliminary design; and
- o Prefinal/final design.

### **Design Preparation**

This task will involve reviewing all available data, requirements, goals and criteria. Any data deficiency will be identified and any necessary additional data will be acquired during this task. For example, geotechnical test of potential cover materials might be necessary if soils from the NSL borrow area are not available.

### **Preliminary Design**

Preliminary construction plans and specifications will be submitted when at least 30% of the design has been completed. This will include: (1) a review of the technical requirements of

the project; (2) a preliminary design to accomplish those requirements; (3) the identification and addressing of all required construction/operation permits and other requirements of any applicable Federal, State or local laws and regulations; (4) any additional information obtained; (5) calculations governing the selection of equipment, pipelines, number of trenches, etc.; and (6) any drawings that could be drawn at this stage.

The preliminary design will be reviewed by EPA at this time to evaluate whether it will meet the remediation criteria and goals.

#### **Prefinal/Final Design**

Construction plans and specifications will be submitted to the EPA for approval when they are 95% completed. The prefinal design will include all specifications, drawings, cost estimates and schedule.

Once any required changes are completed, the final design report and documents will be submitted in a reproducible form ready for bid advertisement.

## IMPLEMENTATION OF REMEDIAL ACTION

After the Remedial Design (RD) is approved, implementation of the Remedial Action (RA) will be completed by a contractor selected by the ECC Potentially Responsible Parties (PRPs). Procedures and responsibilities for project activities are described below.

### Procurement Activities

The PRPs will be responsible for the selection of a contractor to implement the RA. This will include bid advertisement, site inspection with the bidders, review of bids and final selection.

### Inspection and Oversight

Construction inspection will be the responsibility of the PRPs or their contractor. The EPA will oversee the construction activities to ensure that the remedial action is appropriately implemented.

The PRPs or their contractors will select one full-time inspector, who will be responsible for determining whether: (1) the work is done in accordance with the specification and environmental requirements; (2) the Health and Safety Plan is adhered to; and (3) the Quality Assurance Project Plan (QAPP) provisions are met.

### Reporting

A monthly progress report will be prepared by the PRPs or their representative for submission to the EPA and the State of Indiana. The site inspector will review and initial all reports.

The purpose of the progress reports is to allow EPA to monitor the construction activities. The progress reports will include the elements shown in Table 4.

#### **Final Acceptance**

Final acceptance activities include prefinal construction conference, inspection and report preparation; final inspection; RA report preparation; and acceptance of completed project.

#### **Prefinal Construction Conference**

The prefinal construction conference will be attended by representatives of the PRPs, their contractor, the EPA and the State of Indiana. The agenda will include the items shown in Table 5. The purpose of the conference is to specify the requirements and schedule for project completion.

#### **Prefinal Inspection**

The same parties represented at the Prefinal Conference will be represented at the prefinal inspection. At the time of prefinal inspection, all construction work at the site must be completed, including equipment start-up and operator training. The inspection will consist of a walk through the site to determine what remains to be done according to the plans and specifications.

#### **Prefinal Inspection Report**

The PRPs or their representative will prepare a prefinal inspection report for submission to EPA and the State of Indiana. The report will include any unfinished construction items found during the prefinal inspection, how they will be resolved,

expected date of completion, and proposed schedule for final inspection.

#### **Final Inspection**

The final inspection will also consist of a walk through the facility to check the construction items found unresolved during the prefinal inspection. All clean-up and demobilization activities will be completed before the final inspection. However, equipment necessary to correct construction problems may remain on site.

Should any construction problem be detected, a second prefinal inspection report will be issued and another final inspection scheduled.

#### **Remedial Action Report**

Once the final inspection has been completed and the construction work is found to be satisfactory, a RA report including the items listed in Table 6 will be prepared by the PRPs or their representative and submitted to the EPA and the State of Indiana for approval.

#### **Operation and Maintenance Assumption**

The PRPs will assume responsibility for the operation and maintenance (O & M) activities at the site on the date the RA construction work is certified as completed in the RA report. O & M reports will be submitted to the EPA as specified in the RD.

### **Acceptance of Completed Project**

Once the EPA and the State of Indiana review the RA report and agree that the remedy has been appropriately implemented and is performing according to specifications, the EPA Region V Administrator will notify the PRPs in writing that the EPA is satisfied with the completed project.

### **Deletion of Site from the National Priorities List**

The EPA will recommend deletion of the site from the National Priorities List if the site meets the criteria listed in the EPA memorandum "Interim Procedures for Deleting Sites from National Priorities List".

**TABLE 1**  
**ECC SITE**  
**REMEDIAL DESIGN REPORT OUTLINE**

1. Introduction
2. Site Description
3. Design Criteria
4. Engineering Analyses
5. Remedial Action Construction Requirements
6. Operation and Maintenance Requirements
7. Post-Remedial Action Construction Requirements
8. Estimated Remedial Action Cost and Schedule

**APPENDICES**

- A. Project Specifications
- B. Operation and Maintenance Plan
- C. Quality Assurance Project Plan
- D. Health and Safety Specifications



TABLE 2

ECC SITE REMEDIAL DESIGN  
HEALTH AND SAFETY PLAN REFERENCES\*

- o CERCLA sections 104(f) and 111(c)(6)
- o EPA Order 1440.2 - Health and Safety Requirements for Employees Engaged in Field Activities
- o EPA Order 1440.1 - Respiratory Protection
- o EPA Occupational Health and Safety Manual
- o EPA Interim Standard Operating Safety Guide (September 1982)
- o Part 1910 of 29 CFR revised 1 July 1982, OSHA Standards for General Industry and proposed changes of August 10, 1987 for Hazardous Waste Operations
- o NIOSH, (National Institute of Occupational Safety and Health) Manual of Analytical Methods, Volumes I-VII
- o Threshold Limit Values (TVL) for Chemical Substances and Physical Agents in the Work Environment with Intended Changes Adopted by ACGIH (American Conference of Governmental Industrial Hygienists), latest edition
- o ANSI Z 88.2 - 1980, American National Standard Practices for Respiratory Protection
- o Air Sampling Instruments for Evaluation of Atmospheric Contaminants, 6th Edition, 1983, American Conference of Government Industrial Hygienists
- o Appropriate State health and safety statutes

\*From U.S. EPA "Superfund Remedial Design and Remedial Action Guidance," June 1986. OSWER Directive 9355.0-4A.

**TABLE 3**

**ECC SITE REMEDIAL DESIGN  
BASIC ELEMENTS OF OPERATION AND MAINTENANCE PLAN\***

- A. Description of Normal Operation and Maintenance**
  - 1. Description of tasks for operation
  - 2. Description of tasks for maintenance
  - 3. Description of prescribed treatment or operating conditions
  - 4. Schedule showing frequency of each O & M task
- B. Description of Potential Operating Problems**
  - 1. Description and analysis of potential operating problems
  - 2. Sources of information regarding problems
  - 3. Common remedies
- C. Description of routine Monitoring and Laboratory Testing**
  - 1. Description of monitoring tasks
  - 2. Description of required laboratory tests and their interpretation
  - 3. Required QA/QC
  - 4. Schedule of monitoring frequency and when, if so provided, to discontinue
- D. Description of Alternate O & M**
  - 1. Should systems fail, alternate procedures to prevent undue hazard
  - 2. Analysis of vulnerability and additional resource requirements should a failure occur
- E. Safety Plan**
  - 1. Description of precautions, of necessary equipment, etc., for site personnel
  - 2. Safety tasks required in event of systems failure (May be linked to site safety plan developed during remedial responses)

TABLE 3 (cont'd)

F. Description of Equipment

1. Equipment necessary to plan
2. Installation of monitoring components
3. Maintenance of site equipment
4. Replacement schedule for equipment and installed components

G. Records and Reporting Mechanisms Required

1. Daily Operating Logs
2. Laboratory Records
3. Records for Operating Costs
4. Mechanism for reporting emergencies
5. Personnel and maintenance records
6. Monthly/Annual Reports to State agencies

\*From U.S. EPA "Superfund Remedial Design and Remedial Action Guidance," June 1986. OSWER Directive 9355.0-4A.

**TABLE 4**

**ECC SITE REMEDIAL ACTION  
PROGRESS REPORT OUTLINE**

1. Summary of work performed during the reporting period.
2. Community relations activities
3. Problems found and how they were/will be solved
4. Estimate of project completion in terms of percentage
5. Work scheduled for the next reporting period

**TABLE 5**

**ECC SITE REMEDIAL ACTION  
PREFINAL CONSTRUCTION CONFERENCE AGENDA\***

1. Final O & M Plan submission
2. Clean-up responsibilities
3. Demobilization Activities
4. Prefinal inspection schedule
5. Facility start-up and testing
6. Operator training

\*From EPA "Superfund Remedial Design and Remedial Action Guidance," June 1986, OSWER Directive 9355.0-4A.

**TABLE 6**

**ECC SITE  
REMEDIAL ACTION REPORT OUTLINE\***

- o Summary of work described in Exhibit A of the consent decree;
- o Modifications to Exhibit A of the consent decree and justification for them;
- o Description of prefinal inspection outstanding items and how they were resolved;
- o Final Construction Inspection;
- o Certification that the work included in Exhibit A of the consent decree has been completed;
- o Certification that the remedy is operational and functional; and
- o Specific documentation required to delete the site from the NPL list.

\*From U.S. EPA "Superfund Remedial Design and Remedial Action Guidance," June 1986, OSWER Directive 9355.0-4A.

Hand-delivered  
on Feb. 24, 1989  
EFM

PROPOSED CLEANUP STANDARDS  
ENVIRONMENTAL CONSERVATION  
AND  
CHEMICAL CORPORATION  
(ECC) SITE

FEBRUARY 23, 1989

PREPARED BY:

ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, ILLINOIS 60015

PROJECT NO. 8076

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**PROPOSED CLEANUP STANDARDS  
ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION  
(ECC) SITE**

**1.0 INTRODUCTION**

This document presents a set of site-specific soil cleanup standards to be used at the ECC site to determine the end point of vapor extraction activities and to accomplish "Clean Closure" of the site.

Achieving these standards, in accordance with Federal Regulations, will result in the cleanup of the soil and ground water at the site so that without any further remedial action, thereafter, the site will not adversely affect any environmental media, including ground water, surface water, or the atmosphere so that direct contact through dermal exposure, inhalation, or ingestion will not result in a threat to human health or the environment.

**2.0 CLEANUP STANDARDS**

Table 1 lists the proposed cleanup limits. The equations for calculation of the risks, supporting data and complete references are included in the Appendix.

The calculation of risk-based concentrations shown in Table 1 follows the procedures presented in the USEPA Draft RCRA Facility Investigation (RFI) Guidance, July, 1987. The assumed ingestion rates for soil are either 0.2 grams of soil per day for a 70 kilogram person for 70 years (for compounds with potency factors) or 1 gram of soil per day for a 17 kilogram child for 5 years (for compounds with reference doses). The ingestion rate for

TABLE 1 (Page 1 of 2)  
PROPOSED CLEANUP STANDARDS  
ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION (ECC) SITE

Compounds	Acceptable Ground Water Concentration (1) (ug/l)		Acceptable Stream Concentration (2) (ug/l)		Acceptable Soil Concentration	
					Value (ug/kg)	Method
VOLATILE ORGANICS (VOCs):						
Acetone	3,500	RB			490	(3)
Chlorobenzene	1,050	RB			177,000	(3)
Chloroform	100	MCL	15.7		2,300	(3)
1,1-Dichloroethane	0.38	RB			5.7	(3)
1,1-Dichloroethene	7	MCL	1.85		120	(3)
Ethylbenzene	3,500	RB	3,280		1,200,000	(3)
Methylene Chloride	4.7	RB	15.7		20	(3)
Methyl Ethyl Ketone	1,750	RB			780	(3)
Methyl Isobutyl Ketone	1,750	RB			8,900	(3)
Tetrachloroethene	0.63	RB	3.85		130	(3)
Toluene	10,500	RB	3,400		1,250,000	(3)
1,1,1-Trichloroethane	200	MCL	5,280		7,200	(3)
1,1,2-Trichloroethane	0.61	RB	41.8		22	(3)
Trichloroethene	5	MCL	80.7		240	(3)
Total Xylenes	70,000	RB			31,000,000	(3)
BASE NEUTRAL/ACID ORGANICS:						
Bis(2-ethylhexyl)phthalate	2.5	RB	50,000		5,500	(4)
Di-n-Butyl Phthalate	3,500	RB	154,000		1,700,000	(4)
Diethyl Phthalate	28,000	RB	52,100		11,300,000	(3)
Isophorone	8.5	RB			52	(3)
Naphthalene	14,000	RB	620		3,480,000	(3)
Phenol	1,400	RB	570		9,800	(3)
PESTICIDES/PCBs:						
PCBs					10,000	(5)
INORGANICS:						
Antimony	14	RB			500,000	(6)
Arsenic	50	MCL	(7)		97,000	(6)
Barium	1,000	MCL			5,000,000	(6)
Beryllium	175	RB			7,000	(6)
Cadmium	10	MCL			10,000	(6)
Chromium	50	MCL	11		1,500,000	(6)
Lead	50	MCL	10		700,000	(6)
Manganese	7,000	RB			7,000,000	(6)
Nickel	700	RB	100		700,000	(6)
Silver	50	MCL			5,000	(6)
Tin	21,000	RB			20,000	(6)
Vanadium	245	RB			500,000	(6)
Zinc	7,000	RB	47		2,000,000	(6)
Cyanide	700	RB	5.2		340,000	(4)

TABLE 1 (Page 2 of 2)

NOTES:

- (1) MCL = Drinking water Maximum Contaminant Level. 40 CFR 141.  
RB = risk-based standard. U.S. EPA, Draft RCRA Facility Investigation Guidance, 1987.
- (2) Stream Criteria, from Table 1 of the Record of Decision for the site, September 25, 1987.
- (3) Acceptable soil value is based on ingestion of ground water at the site boundary, assuming a dilution of leachate to ground water of 1:196.
- (4) Acceptable soil value is based on ingestion of soil, assuming an ingestion rate of 1 gram of soil per day by a 17 kilogram child, as per the RCRA Facility Investigation Guidance.
- (5) 40 CFR Part 761.125 .
- (6) Upper limit of background concentrations listed in U.S. Geological Survey, Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States, Professional Paper 574-F, 1975.
- (7) Value in Table 1 of the ROD is below treatability and detection limits.

ground water is 2 liters of water per day by a 70 kg person for 70 years.

Three columns of data, corresponding to ground water, surface water and soil cleanup standards, are presented in Table 1. Ground water concentrations are based on either the drinking water Maximum Contaminant Level (MCL) or the appropriate risk-based concentration. These limits assume, as a worst case, that the ground water in the till could be utilized as a lifetime source of drinking water. Note that, however, use of the ground water in the till as a source of drinking water was rejected as infeasible in the ECC Remedial Investigation (RI), page 6-22.

Surface water concentrations are taken from the Record of Decision (ROD) for the site, dated September 25, 1987.

Soil concentrations are selected in the following order: (1) regulated cleanup level, as for PCBs; (2) background concentrations, as for metals; or (3) lowest of the risk-based concentrations for soil or ground water ingestion.

Table 2 presents the compounds detected in soils at the site at levels above the proposed cleanup standards. Table 3 shows the vapor pressure and solubility of these compounds.

### 3.0 VOLATILE ORGANICS (VOCs)

The vapor extraction system to be installed at the site, consisting of trenches to inject/extract air from the soils, will be able to reduce the current VOCs soil concentrations to the levels shown in Table 1. Ground water concentrations in the till will also be reduced by eliminating the source of VOCs, and by extracting ground water from the till during the vapor extraction activities.

TABLE 2  
COMPOUNDS DETECTED IN THE SOIL AT CONCENTRATIONS  
ABOVE THE PROPOSED SOIL CLEANUP STANDARDS

Compound	Soil Concentration (ug/kg)	
	Cleanup Standard	Maximum Detected Concentration
VOLATILE ORGANICS (VOCs):		
Acetone	490	650,000
Chloroform	2,300	2,900
1,1-Dichloroethane	5.7	35,000
1,1-Dichloroethene	120	380
Ethylbenzene	1,200,000	1,500,000
Methylene Chloride	20	310,000
Methyl Ethyl Ketone	780	2,800,000
Methyl Isobutyl Ketone	8,900	190,000
Tetrachloroethene	130	650,000
Toluene	1,250,000	2,000,000
1,1,1-Trichloroethane	7,200	1,100,000
1,1,2-Trichloroethane	22	550
Trichloroethene	240	4,800,000
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	5,500	370,000
Isophorone	52	440,000
Phenol	9,800	570,000
PESTICIDES/PCBs:		
PCBs	10,000	39,000
INORGANICS:		
Cadmium	10,000	27,000

TABLE 3  
CHEMICAL PROPERTIES OF COMPOUNDS  
DETECTED IN THE SOILS ABOVE CLEANUP STANDARDS

Compound	Solubility (ug/l)	Vapor Pressure (mm Hg)
VOLATILE ORGANICS (VOCs):		
Acetone	1,000,000,000	270
Chloroform	8,200,000	151
1,1-Dichloroethane	5,500,000	182
1,1-Dichloroethene	2,250,000	600
Ethylbenzene	152,000	7
Methylene Chloride	20,000,000	362
Methyl Ethyl Ketone	268,000,000	77.5
Methyl Isobutyl Ketone	17,000,000	6
Tetrachloroethene	200,000	17.8
Toluene	535,000	28.1
1,1,1-Trichloroethane	4,400,000	123
1,1,2-Trichloroethane	4,500,000	30
Trichloroethene	1,100,000	57.9
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	1,300	0.0000002
Isophorone	12,000	0.38
Phenol	93,000,000	0.341
PESTICIDES/PCBs:		
Aroclor-1232	1,450	0.00406
Aroclor-1260	2.7	0.0000405

REFERENCES:

U.S. EPA, Superfund Public Health Evaluation Manual, 1986

U.S. EPA, Water-Related Environmental Fate of 129 Priority Pollutants, December 1979.

#### 4.0 BASE NEUTRAL/ACID ORGANICS

Isophorone and phenol will be reduced to acceptable levels by the vapor extraction system. Bis(2-ethylhexyl) phthalate (EHP) will not be extracted by soil aeration due to its low vapor pressure (see Table 3). However, the high affinity of EHP for organic carbon in the soils will prevent any significant leaching to the ground water. In addition, EHP was detected in only 8 of 35 soil samples collected during the RI and EHP is easily biodegraded under aerobic conditions (like those existing during vapor extraction), with a half-life of about 2 weeks (USEPA, Water-Related Environmental Fate of 129 Priority Pollutants, December, 1979). Moreover, the risk from any kind of contact or ingestion will be eliminated by installation and maintenance of a cap over the site. Therefore, the overall risk to human health and the environment resulting from contact to or migration of EHP is not significant.

#### 5.0 PESTICIDES/PCBS

PCBs were detected during the RI above the proposed cleanup standard at only one location (TP-9, 1-3'). Overall, PCBs were detected in only 6 of the 35 soil samples collected and, as EHP, have a high affinity for organic carbon in the soils and thus, will not be leached from the soils at any significant concentration. Moreover, the risk from any kind of contact or ingestion will be eliminated by installation and maintenance of a cap over the site. Therefore, the overall risk to human health and the environment resulting from PCBs in the soils is negligible.



## 6.0 INORGANICS

Cadmium was the only inorganic compound detected at the site at concentrations above the respective cleanup standards, and only in one location out of 36 samples collected (TP-8, 2.5-4'). As for EHP and PCBs, the risk from any kind of contact or ingestion will be eliminated by installation and maintenance of a cap over the site, and thus, the overall risk due to the presence of cadmium in the soils is also not significant.

## 7.0 SUMMARY

A set of cleanup standards that are protective of human health and the environment are proposed. Soil vapor extraction and installation and maintenance of a cap over the site will reduce the risks from the site to human health and the environment to within acceptable ranges.

## APPENDIX

### CALCULATION OF PROPOSED RISK-BASED CLEANUP STANDARDS

The equations used to calculate risk-based concentrations are shown in Table A1. The ingestion rates and acceptable risks are listed in Table A2. The potency factors and reference doses for compounds without any regulatory or background level are from a memorandum from the USEPA Toxics Integration Branch, OERR, Washington, D.C., dated December 19, 1988, with the Corrections to the July, 1988 Update of the Characterization Tables in the Superfund Public Health Evaluation Manual.

Table A3 presents the calculation of risk-based acceptable ground water concentrations in the till for compounds without a drinking water Maximum Contaminant Level. Table A4 shows that the resulting concentrations of compounds at Unnamed Ditch will be below the Stream Criteria presented in Table 1 of the Record of Decision (ROD) for the site, dated September 25, 1987. The dilution obtained from discharge of the ground water in the till to Unnamed Ditch is 1:1800, as presented in Appendix C of the ECC Remedial Investigation. Note that most of the calculated concentrations in the ditch are below current detection limits.

Tables A5 and A6 list the acceptable risk-based soil concentrations, based on soil and ground water ingestion, respectively. The calculation of acceptable soil concentrations based on ground water ingestion follows the procedures presented in Appendix C of the ECC RI. It is assumed that the volume of leachate from the soils will be reduced by 99 percent from the 7.8 in/yr used in the RI, by installing the cap over the site.

Finally, Table A7 presents the complete list of references used for the calculation of the proposed cleanup standards.

TABLE A1  
EQUATIONS USED TO CALCULATE RISK-BASED CONCENTRATIONS \*

SOIL (concentrations in ug/kg):

$$\frac{\text{Risk} * \text{Body Weight (kg)} * 1000 \text{ (ug/mg)} * 1000 \text{ (g/kg)}}{\text{Ingestion rate (g/d)} * \text{Potency Factor (mg/kg/d)} - 1}$$

or

$$\frac{\text{Risk} * \text{Body Weight (kg)} * \text{Reference Dose (mg/kg/d)} * 1000 \text{ (ug/mg)} * 1000 \text{ (g/kg)}}{\text{Ingestion rate (g/d)}}$$

GROUND WATER (concentrations in ug/l):

$$\frac{\text{Risk} * \text{Body Weight (kg)} * 1000 \text{ (ug/mg)}}{\text{Ingestion rate (l/d)} * \text{Potency Factor (mg/kg/d)} - 1}$$

or

$$\frac{\text{Risk} * \text{Body Weight (kg)} * \text{Reference Dose (mg/kg/d)} * 1000 \text{ (ug/mg)}}{\text{Ingestion rate (l/d)}}$$

TABLE A2  
INGESTION RATES AND ACCEPTABLE RISKS

INGESTION RATES \* :

SOILS:

0.2 grams per day by a 70-kilogram person for 70 years

or

1 gram per day by a 17-kilogram child for 5 years

GROUND WATER:

2 liters of water per day by a 70-kilogram person for 70 years

ACCEPTABLE RISKS:

COMPOUNDS WITH POTENCY FACTORS:

$10^{-6}$

COMPOUNDS WITH REFERENCE DOSES:

1

\* From U.S. EPA, RCRA Facility Investigation Guidance, 1987.

TABLE A3  
ECC - ACCEPTABLE HEALTH-BASED GROUND WATER CONCENTRATIONS

Compound	Potency Factor (1) (mg/kg/d)-1	Reference Dose (1) (mg/kg/d)	Acceptable Ground Water Concentration (2) (ug/l)
VOLATILE ORGANICS (VOCs):			
Acetone		0.1	3,500
Chlorobenzene		0.03	1,050
1,1-Dichloroethane	0.091		0.38
Ethylbenzene		0.1	3,500
Methylene Chloride	0.0075		4.7
Methyl Ethyl Ketone		0.05	1,750
Methyl Isobutyl Ketone		0.05	1,750
Tetrachloroethene	0.051		0.69
Toluene		0.3	10,500
1,1,2-Trichloroethane	0.057		0.61
Total Xylenes		2	70,000
BASE NEUTRAL/ACID ORGANICS:			
Bis(2-ethylhexyl)phthalate	0.014		2.5
Di-n-Butyl Phthalate		0.1	3,500
Diethyl Phthalate		0.8	28,000
Isophorone	0.0041		8.5
Naphthalene		0.4	14,000
Phenol		0.04	1,400
INORGANICS:			
Antimony		0.0004	14
Beryllium		0.005	175
Manganese		0.2	7,000
Nickel		0.02	700
Tin		0.6	21,000
Vanadium		0.007	245
Zinc		0.2	7,000
Cyanide		0.02	700

- (1) From USEPA Toxics Integration Branch, OERR, Washington, D.C. December 1988 correction to the July 1988 Update of the Risk Characterization Tables in the Superfund Public Health Evaluation Manual.
- (2) Acceptable ground water concentrations calculated using an ingestion rate of 2 liters per day by a 70 kg adult for 70 years. Acceptable risk = 1E-06 for compounds with potency and 1 for compounds with reference dose.

TABLE A4  
COMPARISON OF SITE-SPECIFIC STREAM CRITERIA  
WITH STREAM CONCENTRATIONS BASED ON DISCHARGE  
OF GROUND WATER FROM THE TILL

Compounds	Acceptable Stream Concentration (1) (ug/l)	Concentration at Unnamed Ditch due to Discharge of Till Water at Acceptable Concentrations (2) (ug/l)
VOLATILE ORGANICS (VOCs):		
Chloroform	15.7	0.056
1,1-Dichloroethene	1.85	0.0039
Ethylbenzene	3,280	1.9
Methylene Chloride	15.7	0.0026
Tetrachloroethene	8.85	0.00038
Toluene	3,400	5.8
1,1,1-Trichloroethane	5,280	0.11
1,1,2-Trichloroethane	41.8	0.00034
Trichloroethene	80.7	0.0028
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	50,000	0.0014
Di-n-Butyl Phthalate	154,000	1.9
Diethyl Phthalate	52,100	15.6
Naphthalene	620	7.8
Phenol	570	0.78
INORGANICS:		
Arsenic	0.0175	0.028
Chromium	11	0.028
Lead	10	0.028
Nickel	100	0.39
Zinc	47	3.9
Cyanide	5.2	0.39

- (1) From Table 1 of the Record of Decision (ROD) for the site, September 25, 1987.
- (2) Assuming a dilution of 1:1800 for discharge of till ground water at acceptable concentrations into Unnamed Ditch (from ECC Remedial Investigation, Appendix C).

TABLE A5  
ECC - ACCEPTABLE SOIL CONCENTRATIONS  
BASED ON SOIL INGESTION

Compounds	Potency Factor (1)- (mg/kg/d)-1	Reference Dose (1) (mg/kg/d)	Acceptable Soil Concentrations (2) (ug/kg)
VOLATILE ORGANICS (VOCs):			
Acetone		0.1	1,700,000
Chlorobenzene		0.03	510,000
Chloroform	0.0061		57,377
1,1-Dichloroethane	0.091		3,846
1,1-Dichloroethene	0.6		583
Ethylbenzene		0.1	1,700,000
Methylene Chloride	0.0075		46,667
Methyl Ethyl Ketone		0.05	850,000
Methyl Isobutyl Ketone		0.05	850,000
Tetrachloroethene	0.051		6,863
Toluene		0.3	5,100,000
1,1,1-Trichloroethane		0.09	1,530,000
1,1,2-Trichloroethane	0.057		6,140
Trichloroethene	0.011		31,818
Total Xylenes		2	34,000,000
BASE NEUTRAL/ACID ORGANICS:			
Bis(2-ethylhexyl)phthalate	0.014		25,000
Di-n-Butyl Phthalate		0.1	1,700,000
Diethyl Phthalate		0.8	13,600,000
Isophorone	0.0041		85,366
Naphthalene		0.4	6,800,000
Phenol		0.04	680,000
INORGANICS:			
Cyanide		0.02	340,000

- (1) From USEPA Toxics Integration Branch, OERR, Washington, D.C.  
December 19, 1988 corrections to the July 1988 Update of the  
Characterization Tables in the Superfund Public Health Evaluation  
Manual.
- (2) Intake for compounds with potency: 0.2 g of soil/d by  
70 kg resident adults.  
Intake for compounds with reference dose: 1 g of  
soil/d by 17 kg resident children.  
Acceptable risks: 1E-06 for compounds with potency and  
1 for compounds with reference doses.

**TABLE A6**  
**ECC - ACCEPTABLE SOIL CONCENTRATIONS BASED ON GROUND WATER INGESTION AT THE SITE**

Compound	Solubility (1) (ug/l)	Log Kow (1)	Kd (2)	Acceptable Ground Water Concentration (3) (ug/l)		Acceptable Leachate Concentration (4) (ug/l)	Acceptable Soil Concentration (5) (ug/kg)
<b>VOLATILE ORGANICS (VOCs):</b>							
Acetone	1,000,000,000	-0.24	0.00071	3,500	RB	686,275	490
Chlorobenzene	466,000	2.84	0.858	1,050	RB	205,882	176,620
Chloroform	8,200,000	1.97	0.116	100	MCL	19,608	2,269
1,1-Dichloroethane	5,500,000	1.79	0.076	0.38	RB	74.5	5.70
1,1-Dichloroethene	2,250,000	1.84	0.086	7	MCL	1,373	118
Ethylbenzene	152,000	3.15	1.75	3,500	RB	686,275	1,202,042
Methylene Chloride	20,000,000	1.25	0.022	4.7	RB	922	20.3
Methyl Ethyl Ketone	268,000,000	0.26	0.00226	1,750	RB	343,137	774
Methyl Isobutyl Ketone	17,000,000		0.02604	1,750	RB	343,137	8,935
Tetrachloroethene	200,000	2.88	0.941	0.69	RB	135	127
Toluene	535,000	2.69	0.607	10,500	RB	2,058,824	1,250,377
1,1,1-Trichloroethane	4,400,000	2.17	0.183	200	MCL	39,216	7,193
1,1,2-Trichloroethane	4,500,000	2.17	0.183	0.61	RB	120	21.9
Trichloroethene	1,100,000	2.29	0.242	5	MCL	960	237
Total Xylenes	198,000	3.25	2.26	70,000	RB	13,725,490	30,970,595
<b>BASE NEUTRAL/ACID ORGANICS:</b>							
Bis(2-ethylhexyl)phthalate	1,300	8.7	621472	2.5	RB	490	304,643,220
Di-n-Butyl Phthalate	13,000	5.2	197	3,500	RB	686,275	134,971,303
Diethyl Phthalate	4,320,000	3.22	2.06	28,000	RB	5,490,196	11,298,207
Isophorone	12,000		0.031	3.5	RB	1,667	51.7
Naphthalene	30,000	3.01	1.269	14,000	RB	2,745,098	3,483,209
Phenol	93,000,000	1.46	0.036	1,400	RB	274,510	9,817

- (1) From ECC RI, Table 4-4, and Verschueren, 1983, Handbook of Environmental Data on Organic Chemicals.
- (2) From ECC RI, Table 4-4. Calculated as  $10^{-\log Kow} \times OC$ , where  $OC$  = organic carbon content = 0.00124. For isophorone and methyl isobutyl ketone, the  $Kd$  is obtained as  $Kd = Koc \times OC$ , where  $Koc$  = organic carbon-water partition coefficient, obtained from  $\log Koc = (-0.55 \times \log S) + 3.64$  (Exhibit A-1 of the Superfund Public Health Evaluation Manual, 1986).
- (3) RB = risk-based concentration, from Table A3. MCL = Maximum Contaminant Level, from Superfund Public Health Evaluation Manual, update of November, 1987.
- (4) Leachate discharge/ground water discharge = 0.0051 (Appendix C of the ECC RI; and reduction of the 7.8 in/yr recharge used in the RI under the current conditions (page 5-8) by 99 percent due to the cap).
- (5) Soil concentration (ug/kg) =  $Kd \times$  Concentration in leachate (ug/l).



## TABLE A7

### REFERENCES

CH2MHILL, Environmental Conservation and Chemical Corporation Feasibility Study, December, 1986.

CH2MHILL, Environmental Conservation and Chemical Corporation Remedial Investigation, March, 1986.

USEPA, Region V, Record of Decision for Environmental Conservation and Chemical Corporation, and Northside Sanitary Landfill, Zionsville, Indiana, September 25, 1987.

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USEPA, Polychlorinated Biphenyls Spill Cleanup Policy, 40 CFR Part 761, published in the Federal Register on April 2, 1987.

USEPA, Superfund Public Health Evaluation Manual, October, 1986, PB87-183125 with updates of November 16, 1987 and July, 1988.

USEPA, Toxics Integration Branch, OERR, Washington, D.C., December, 1988 Memorandum with Corrections to the July, 1988 Update of the Risk Characterization Tables in the Superfund Public Health Evaluation Manual.

USEPA, Water-Related Environmental Fate of 129 Priority Pollutants, December, 1979 PB80-204381.

US Geological Survey, Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States, Professional Paper 574-F, 1975.

Veschveren, K., Handbook of Environmental Data on Organic Chemicals, 1983.



**ERM-North Central, Inc.**  
Environmental Resources Management

102 Wilmet Road • Suite 300 • Deerfield, Illinois 60015 ☎ (312) 940-7200

March 2, 1989

Karen A. Vendl  
Remedial Project Manager  
U.S. Environmental Protection Agency  
Region 5 (5HS-11)  
230 South Dearborn Street  
Chicago, IL 60604

Re: Enviro-Chem ("ECC") Site

Dear Ms. Vendl:

As instructed by the ECC Settling Defendants, enclosed please find five (5) copies of the Exhibit A to the ECC Consent Decree.

Very truly yours,

ERM-North Central, Inc.

A handwritten signature in black ink, appearing to read "Roy O. Ball". The signature is stylized with a large, sweeping "R" and "B".

Roy O. Ball, Ph.D., P.E.  
Principal

jas  
Enc.

cc: A. Sloan  
J. Buck (6 copies)  
D. Albright  
B. Rogers  
H. Keplinger  
J. Kyle  
T. Harker  
N. Bernstein  
J. Amber  
D. Smith

**EXHIBIT A**

**ENVIRONMENTAL CONSERVATION AND  
CHEMICAL CORPORATION (ECC) SITE  
ZIONSVILLE, INDIANA**

**MARCH, 1989**

**PREPARED FOR:**

**ECC SETTLING DEFENDANTS**

**PREPARED BY:**

**ENVIRONMENTAL RESOURCES MANAGEMENT-NORTH CENTRAL, INC.  
102 WILMOT ROAD, SUITE 300  
DEERFIELD, ILLINOIS 60015  
PROJECT NO.: 8076**

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## EXHIBIT A

### 1.0 INTRODUCTION

This document is a Remedial Action Plan (hereafter, "Remedial Action Plan") "Exhibit A" or the "Document" and describes the work to be performed at the Environmental Conservation and Chemical Corporation ("ECC") Superfund site as required by the 1989 ECC Consent Decree ("Consent Decree" or "Decree"). This document is attached as Exhibit A to, and is incorporated by reference into and made an enforceable part of, that Decree.

The purpose of this Exhibit A is to set forth those remedial activities to be performed at the ECC site necessary to achieve a health-based cleanup so that the site will not, once the work is performed, cause or present any risk to human health or the environment. The settling defendants under the Consent Decree ("Settling Defendants") shall arrange to have the work required hereunder performed by a Contractor or Contractors ("Contractor") in accordance with the requirements and specifications set forth herein.

### 2.0 REMEDIAL ACTION PLAN

This Remedial Action Plan (RAP) addresses, in a technically feasible and cost-effective manner, all environmental concerns regarding the ECC site, namely:

- o Direct contact with soils containing volatile organics (VOCs), base neutral/acid organics, and heavy metals;

- o Contamination of ground water by precipitation percolating through soils containing VOCs, base neutral/acid organics, and heavy metals;
- o Contamination of surface waters by overland migration of water in contact with soils containing VOCs, base neutral/acid organics, and heavy metals;
- o Ingestion of ground water containing VOCs, base neutral/acid organics, and heavy metals; and
- o Contamination of surface waters by discharge of ground water containing VOCs, base neutral/acid organics and heavy metals.

Additionally, the RAP complies with the Superfund Amendments and Reauthorization Act (SARA) of 1986 by treating the contaminants at ECC so that they do not present any current or currently foreseeable future risk to health or the environment.

The RAP, which is described in detail in the following sections, includes the components listed below:

- o Soil vapor extraction, concentration, and destruction;
- o Installation of a RCRA-compliant cover;



- o Establishment of access restrictions; and
- o Ground water and surface water monitoring.

The intent of this RAP is to provide for the implementation of a comprehensive remedy that will remediate the site and will constitute "clean closure" by removing and destroying wastes at the site so as to preclude any risk to human health and the environment through any media (air, soil, surface water, or ground water). The soil vapor extraction system to be implemented under this Document will result in a cleanup level for constituents of concern in the site soils so as to obviate the need for ground water interception/collection systems at the site. Specifically, the soil vapor extraction system has been designed and will be operated to achieve Cleanup Standards (as specified in Table 3-1 below) in the soil as well as in the ground and surface water at the site that will protect human health and the environment.

Design of the vapor extraction system in the area beneath the concrete slab and placement of the RCRA-compliant cover over the site in advance of the vapor extraction process will prevent the infiltration of water beneath the concrete slab and migration through the subbase of the concrete slab.

Surface water and ground water sampling will be conducted during and after the operation of the vapor extraction system to verify the effectiveness of the RAP.

The components of the RAP as presented herein are compatible with the proposed remedy for the adjacent Northside Sanitary Landfill (NSL) site. As the remedial design is finalized for the NSL site, the respective RAPs for ECC and NSL will be reviewed to ensure compatibility of design and construction schedules for each system.

## 2.1 Elements of the RAP

### 2.1.1 Soil Vapor Extraction, Concentration and Destruction

The objective of the soil vapor extraction activity is to remove and destroy existing VOCs from the soils (as provided herein) and thereby:

- o prevent contact with contaminated soils;
- o prevent migration of contaminants from the soils to the surface water and ground water;  
and
- o prevent migration of contaminants from the ground water to the surface water.

Enhanced soil vapor extraction has been selected as the technology for removing the existing VOCs and certain base neutral/acid organics of potential concern from the soils at the ECC site. By systematically and uniformly moving air through the zone of contamination, volatilization and hence removal of organics are accelerated. For the ECC site, air movement through

the soil will be controlled by a network of vertical trenches installed throughout the zone of contamination. The process also involves the continuous extraction of organics-laden air from the trench system and treatment of the air by activated carbon to remove the organics. The organics so collected will then be destroyed off-site in conformance with applicable federal and state requirements.

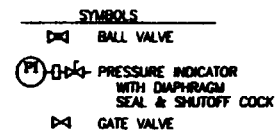
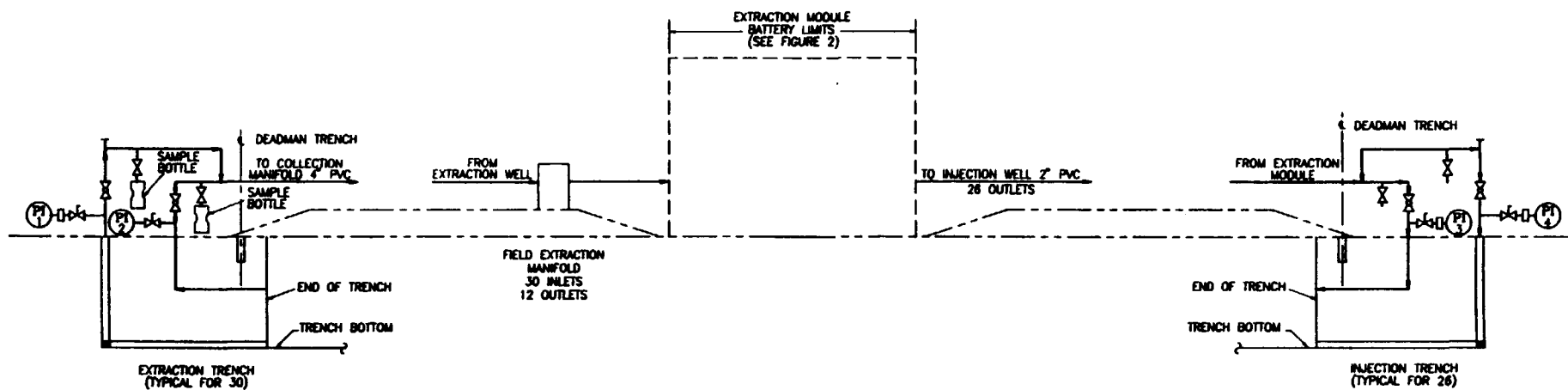
The effectiveness of vapor extraction for organics removal from the ECC soils was demonstrated during a pilot test conducted by Terra Vac in June, 1988. The description of the pilot test, including the results obtained, was previously submitted to USEPA and the State of Indiana, and is specifically incorporated by reference herein and made a part hereof. The test showed an initial high organics extraction rate of 1.9 pounds per day per foot of trench that decreased over the course of the pilot test to a steady state rate of approximately 0.25 pounds per day per foot of trench. Although the Terra Vac pilot study provides the foundation for the system designed herein for ECC, during the conceptual and preliminary engineering phase, several engineering and operational enhancements were developed which will improve overall performance and effectiveness of the vacuum extraction system to be implemented under this RAP. These system enhancements are the result of consultations among ERM-North Central, Inc., Midwest Water Resource, Inc. (MWRI), and Terra Vac, Inc. A summary of the key improvements are:

- o Virtual elimination of surface water infiltration within the zone of contamination;

- o Substantial reduction in the volume of air required for effective remediation;
- o Virtual elimination of atmospheric discharges of treated extraction air;
- o Positive control (collection and removal) of any till moisture encountered in the zone of treatment; and
- o Uniform and essentially horizontal movement of air through the zone of contamination resulting in optimal air/organics contact during operation.

The following discussion and drawings clearly illustrate the design and operation details of the soil vapor extraction system.

The soil vapor extraction process is illustrated in Figures 2-1 and 2-2. The basic operation consists of extraction of air using a single vacuum pump from a network of 30 extraction trenches located throughout the site. Free liquid entrained in the air is removed by gravity in an entrainment separator. Periodically, water which accumulates in the entrainment separator is pumped to an on-site storage tank for subsequent transport to an off-site facility for treatment as necessary. From the vacuum pump, air passes through the carbon adsorption system, which consists of two upflow carbon columns connected in series. Off-gasses from the carbon adsorption system are withdrawn by a pump which boosts the pressure and reinjects air into a network of 26 injection trenches located throughout the site. Each injection trench is



<b>ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION</b> ZIONSVILLE, INDIANA PROCESS FLOW AND INSTRUMENT DIAGRAM	FIGURE NO.
	2-1
<b>ERM</b> ERM-North Central, Inc.	2/28/89
	mo

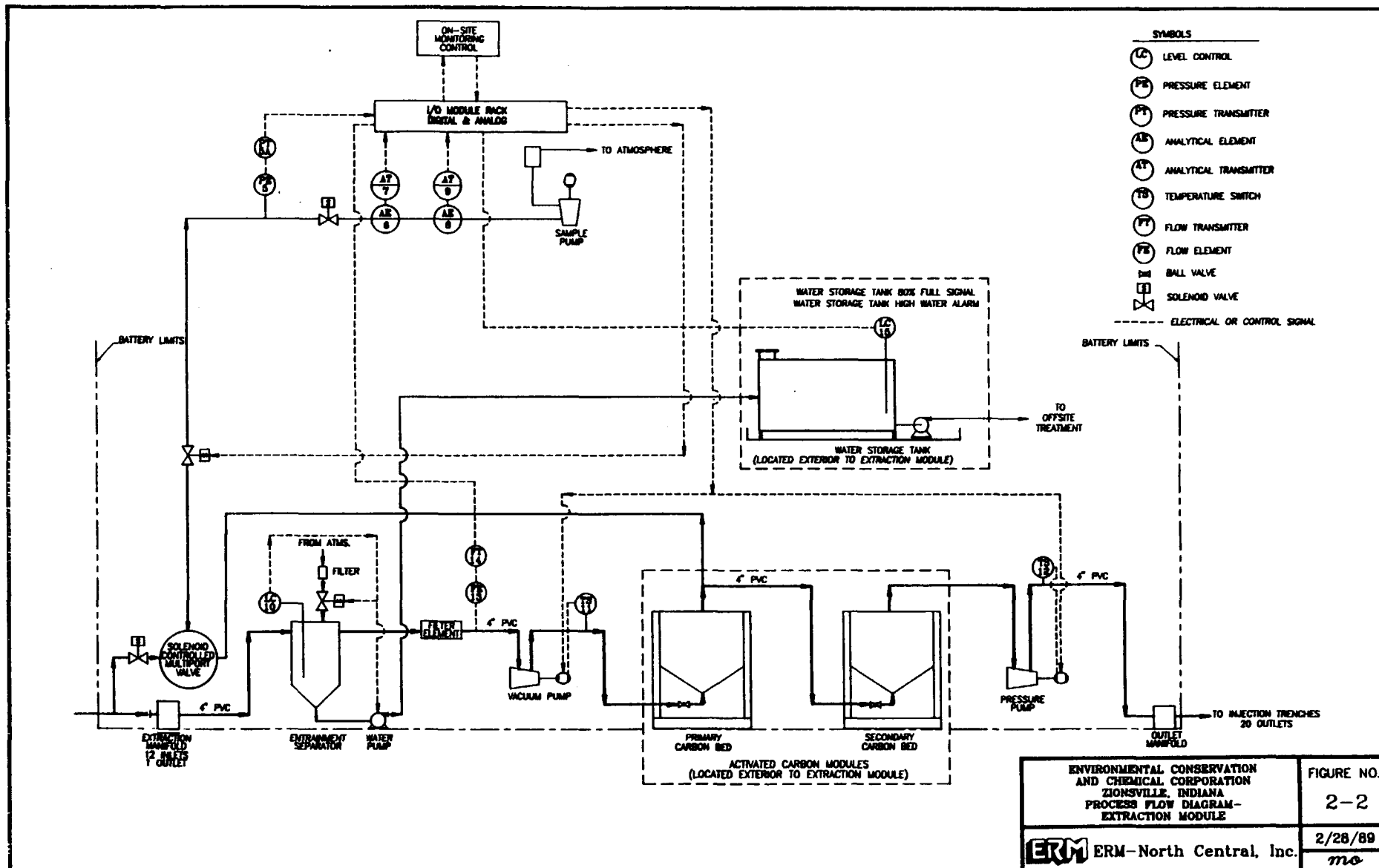


FIGURE NO.  
2-2  
2/28/89  
mo

located between and parallel to a pair of extraction trenches. The injected air then migrates from the injection trench through the soil towards the extraction trench. As the air migrates through the soil towards the extraction trench, the organics are vaporized into the air stream. A RCRA-compliant cover will be placed over the entire trench network to prevent air and water infiltration into the system during operation.

The major system components are:

- o Extraction and injection trenches;
- o Soil vapor extraction system;
- o Water collection system;
- o Carbon adsorption system;
- o Air injection system; and
- o RCRA-compliant cover.

A description of the design and operational features of each of these components is presented below.

#### **Extraction and Injection Trenches**

The area where remedial activity will occur is depicted in Figure 2-3. The layout and construction details for the network of 30 extraction trenches and 26 injection trenches are presented in Figures 2-4 and 2-5. Trench spacing varies between 17 and 18 feet, and trench length varies depending on the configuration of

LOCATION COORDINATES		
POINT	N/S	E/W
1A	0+60 N	1+28 W
1B	3+78 N	1+28 W
1C	0+60 N	1+42 E
1D	3+78 N	1+42 E
2A	0+12 S	0+20 E
2B	0+12 S	1+20 E
2C	0+12 S	1+20 E
2D	0+12 S	1+20 E
3A	0+45 N	1+20 E
3B	2+38 S	0+11 W
3C	1+00 S	0+11 W
3D	2+38 S	0+28 E
3E	1+00 S	1+40 E
3F	1+00 S	1+40 E
MW 11A	2+10 S	0+05 W
EPA SUMP	2+28 S	1+24 E
BENCHMARK	1+62 N	0+27 E

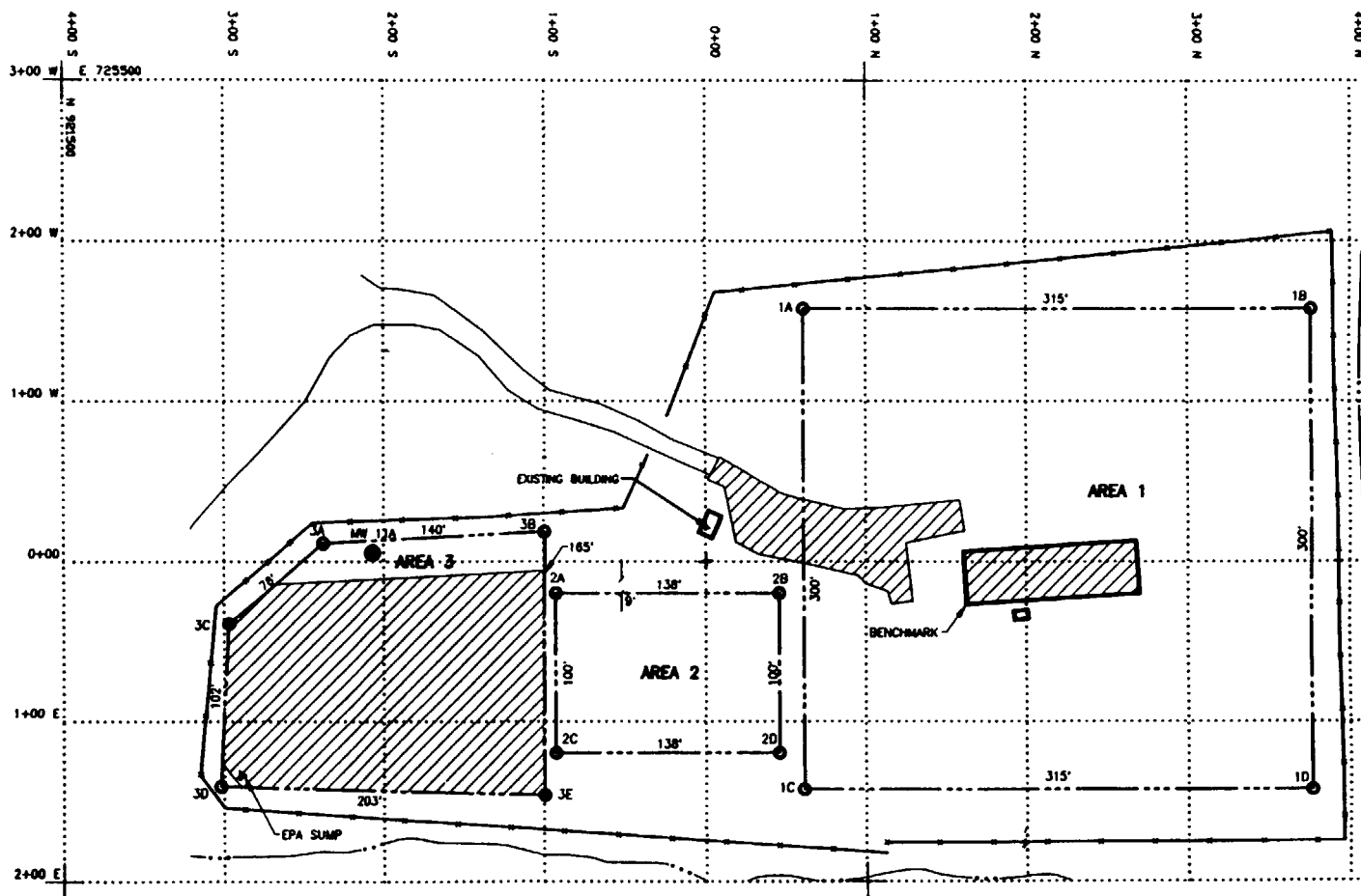
APPROX. SCALE (ft)

0 25 50 100




LEGEND:	
	FENCE LINE
	BUILDING LINE
	PAVEMENT EDGES
	BOUNDARY LINES
	DRAINAGE DITCH
	CONCRETE
	BOUNDARY CORNER

+ REFERENCE POINT FROM  
CH2M-HILL TECHNICAL  
DOCUMENT NO. 2 DATE  
9/16/88 (821700 N; 725900 E)



NOTE: EXISTING FENCE WEST OF  
AREA 3 TO BE RELOCATED TO  
NEW LOCATION SHOWN ON THE DRAWING.

ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION ZIONSVILLE, INDIANA REMEDIAL AREA BOUNDARIES	FIGURE NO. 2-3
 ERM-North Central, Inc.	3/1/89 ca



# NOTES:

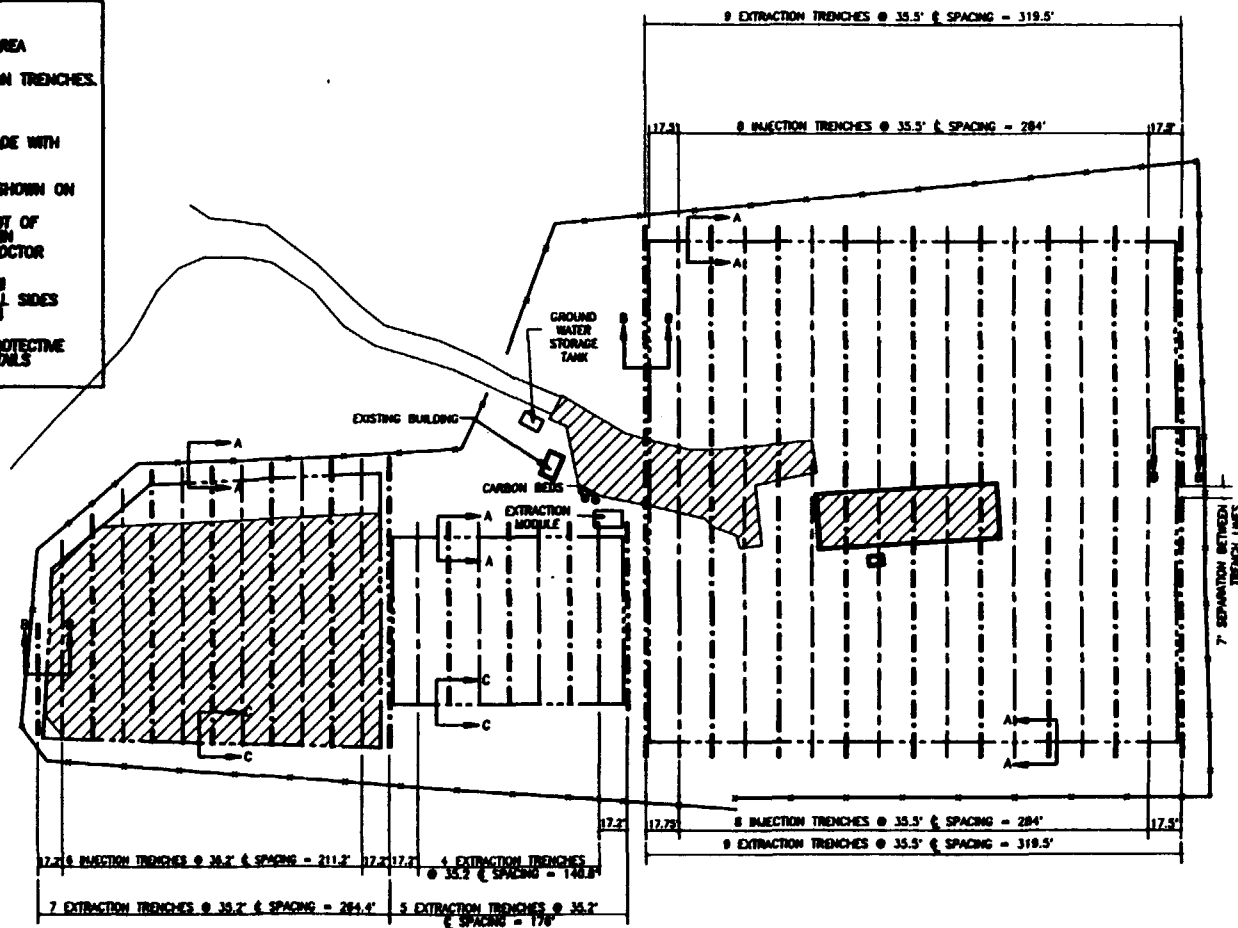
1. GRADE EXISTING TREATMENT SITE (AREA NOS. 1, 2, & 3) TO EVEN SLOPE.
2. EXCAVATE INJECTION AND EXTRACTION TRENCHES.
3. FILL INJECTION TRENCHES WITH GRAVEL AS SHOWN ON DETAILS SHEET.
4. FILL EXTRACTION TRENCHES TO GRADE WITH GRAVEL AS SHOWN ON DETAILS SHEET.
5. EXCAVATE DEADMAN TRENCHES AS SHOWN ON SHEET AND DETAILS SHEET.
6. COVER TREATMENT SITE WITH 1 FOOT OF NATIVE SOIL OF 10-7 PERMEABILITY IN 6" LAYERS COMPACTED TO 95% PROCTOR DENSITY.
7. COVER TREATMENT SITE WITH 60 mil HDPE PLASTIC LINER ANCHORING ALL SIDES IN DEADMAN TRENCH AS SHOWN ON DETAILS SHEET.
8. COVER TREATMENT SITE WITH 6" PROTECTIVE LAYER OF SAND AS SHOWN ON DETAILS SHEET.

APPROX. SCALE (ft)  
0 25 50 100

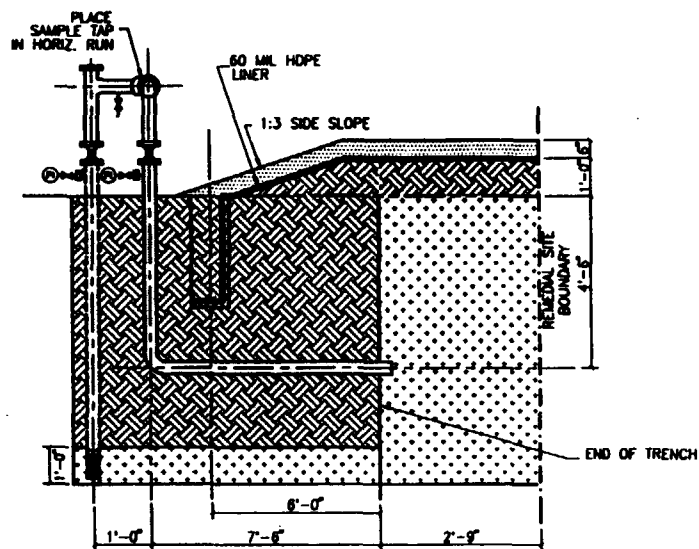


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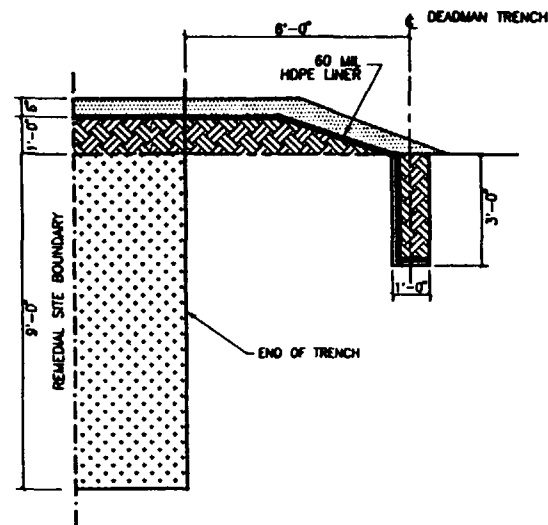
- FENCE LINE
- BUILDING LINE
- PAVEMENT EDGES
- BOUNDARY LINES
- - - INJECTION TRENCHES
- - - EXTRACTION TRENCHES
- ▨ CONCRETE



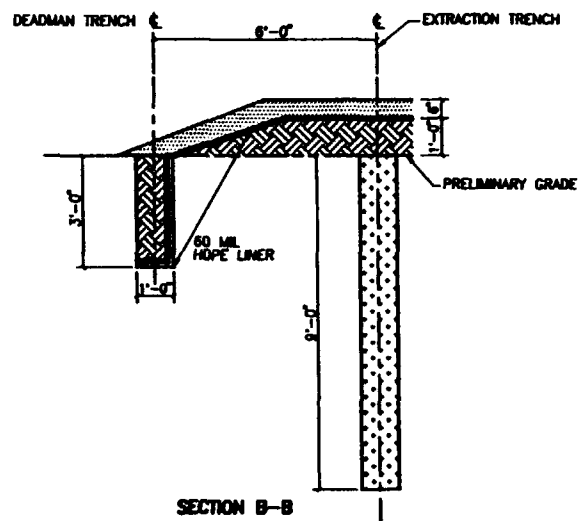
ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION ZIONSVILLE, INDIANA SOIL VAPOR EXTRACTION-TRENCH PLAN	FIGURE NO. 2-4
ERM North Central, Inc.	3/1/89 ca



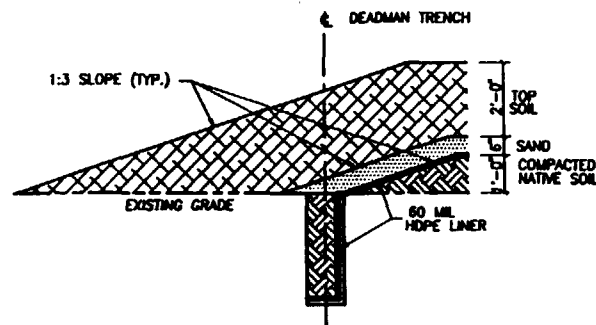
SECTION A-A



SECTION C-C

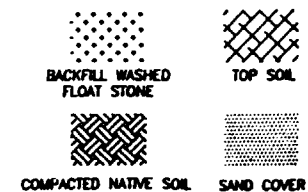


SECTION B-B



NOTE: SLOPE TOP SOIL @ 2% GRADE.  
SEED WITH APPROPRIATE SEED  
MIXTURE OF GRASSES.

FINAL RCRA-COMPLIANT COVER



NOTE: NOT TO SCALE

ENVIRONMENTAL CONSERVATION  
AND CHEMICAL CORPORATION  
ZIONSVILLE, INDIANA  
VAPOR EXTRACTION-TRENCH DETAILS

ERM North Central, Inc.

FIGURE NO.

2-5

3/1/89

CS

the site. The maximum length of any trench will be 165 feet. Construction details of extraction trenches and injection trenches are identical. By implementing minor above-ground piping changes, injection trenches can and will be utilized as extraction trenches. The work required under this RAP will initially involve using the original extraction trenches for extraction; at some point in the process, the extraction trenches will be converted to injection trenches, and vice versa, to ensure complete vapor extraction of the soil.

All trenches are to be a minimum of 9-feet deep as measured from existing grade, and will be backfilled with washed "float" stone. The trench width will be 12-15 inches. Soil removed from the trench excavation will be spread over the surface during construction of the cover system and covered in accordance with the final RCRA-compliant cover detail illustrated in Figure 2-5.

Each trench will be equipped at one end with a vapor extraction pipe and a water collection pipe as illustrated in Section A-A of Figure 2-5. Both pipes will be 4-inch diameter, Schedule 40 PVC. Each pipe segment will be equipped with pressure/vacuum indicator, isolating valve and sample tap. A "T" at the top of the water collection pipe will permit the future installation of air piping to air lift water from the trench network, if necessary. Individual 4-inch, Schedule 40 PVC pipes will be routed from each extraction trench to the extraction module. The extraction module will be located adjacent to the existing concrete pad near the site entrance. Alternatively, two or three extraction trenches will be manifolded together and conveyed to the extraction module via a 4-inch, Schedule 40 PVC pipe. Injection trench piping is identical to the extraction trench piping and, as previously described, will permit it to be

utilized as an extraction trench during the operation of the vapor extraction system. To minimize field piping from the extraction module to the injection trenches, 4 to 8 injection trenches will be manifolded together. Four-inch, Schedule 40 PVC pipe will be used to convey air returned from the extraction module to the injection trench.

The EPA Sump will be backfilled with the trench backfill material and a 4-inch PVC pipe will be installed between the sump and the nearest extraction trench, thereby tying the EPA Sump directly into the vapor extraction system.

#### Soil Vapor Extraction System

The vacuum pump will have a capacity of 500 standard cubic feet per minute (SCFM) and will be capable of developing a vacuum of 18 inches Hg. The normal operating vacuum will be 12 inches Hg. Based on MWRI's experience with soils characteristic of the ECC site and on the Terra Vac pilot study results at the ECC site, the zone of influence at the operating vacuum will be at least 40 feet (20 feet in either side of the trench). The selected spacing between trenches of 17 to 18 feet is well within this zone of influence. The vacuum will be applied at the trench outlet and will be uniformly distributed throughout the entire length and vertical dimension of the trench. The highly porous backfill material used will assure this uniform distribution of vacuum throughout the extraction trench. The reinjection pressure of air in each adjacent injection trench will be approximately 37.4 inches Hg (1.25 atm). Therefore, the pressure differential and driving force for air movement between injection and extraction trenches is approximately 19.4 inches Hg (0.65 atm).

The selection of the design air volume of 500 SCFM is based upon MWRI's experience. The criteria established is to provide at least one air volume change per soil pore volume per day. Based upon an area of treatment of 150,000 square feet, a depth of contamination of 9 feet, and a soil porosity of 10%, 500 SCFM exceeds the MWRI criteria by 400%.

The vacuum pump will operate continuously and will shut down in the event of operating problems such as high operating temperatures, excessive system pressures or vacuums, or high water level in the water collection system. Each trench has a compound pressure gauge which displays the operating pressure/vacuum at each trench.

The air extracted from the system will be continuously monitored by in-line instrumentation as shown on the process flow diagram (Figure 2-2) and described on Table 2-1 (Instrument Summary Sheet). The capability will exist to sample individual trench exhausts or the combined air stream. Sample taps will be provided to collect vapor samples for detailed chemical analysis. The on-line instrumentation will consist of a photoionization detector (PID) and moisture analyzer. The vacuum pump, controls and instrumentation are located in the extraction module building.

#### **Water Collection System**

The high vacuum vapor extraction system selected will be capable of entrainment and movement of water which accumulates in the extraction trenches. Any free liquid in the extracted vapor will be separated by gravity in an entrainment separator located in

# ENVIROCLEAN - NORTH CENTRAL, INC.

## INSTRUMENT SUMMARY SHEET

CLIENT Environmental Conservation  
and Chemical Corporation  
PROJECT NUMBER 8009DSECC

SHEET \_\_\_\_\_ TABLE 2-1  
SPEC NO \_\_\_\_\_  
DATE \_\_\_\_\_ 2/28/89

[illegible]

the vapor extraction module building. A level control system will be utilized to control the removal of water which accumulates in the entrainment separator as required. The separator tank is equipped with a vacuum breaker system which will open the tank to the atmosphere to permit water to be transferred by pump from the separator to an on-site water storage tank. The size of the tank will depend upon the off-site handling/treatment option selected. The tank will be equipped with level measurement and control to advise operating personnel to the status of liquid accumulation in the storage tank.

Periodically, the contents of the water storage tank will need to be removed. The removed water will either be sent to the Indianapolis POTW via the NSL pipeline or truck, or to another off-site facility for handling and treatment as necessary. Any such off-site transportation and handling will be in accordance with all applicable federal, state and local requirements.

#### **Carbon Adsorption System**

From the water entrainment tank, the air passes through a particulate filter preceding the vacuum pump. The exhaust from the vacuum pump will be piped directly to a two-stage carbon adsorption system (primary and secondary). This system will consist of two vessels in series each containing approximately 1,800 pounds of granular activated carbon. The organics contained in the extracted air will be adsorbed on the activated carbon. The moisture content of the air stream will be less than 50% relative humidity and temperatures will be approximately 150°F, both acceptable for efficient operation of carbon adsorption.

During the initial phases of operation, when organics concentrations in the air stream will be highest, the carbon capacity for the organics is expected to be about 25% by weight. During the latter phases of remediation as organic concentration of vapor decreases, the projected carbon capacity for organics will range between 10-15% by weight. Based upon an assumed total mass of organics of about 5,000 pounds (Appendix A), the total quantity of activated carbon required for the entire remediation program is 25,000 pounds. This equates to fourteen 1800-pound carbon vessels for the entire program.

The vapor from the primary carbon vessel will be monitored frequently (approximately once per hour) by an on-line PID analyzer. When the PID analyzer detects organic vapor in the air stream between the primary and secondary carbon vessels, the vacuum extraction system will shut down automatically to permit the removal and replacement of the "spent" primary carbon vessel. An operator will be alerted to this condition, and will disconnect the primary carbon bed from the service. The spent carbon vessel will be removed and replaced by a carbon vessel containing fresh activated carbon. The unit previously serving as the secondary carbon bed will become the primary carbon bed and the unit just placed in operation will be the secondary carbon bed. Once this switch is complete, the soil vapor extraction system (i.e., vacuum pump and injection pump) will be restarted, and the system operation resumed. The arrangement of two activated carbon vessels in series (i.e., primary and secondary) will permit optimal utilization of the activated carbon, and efficient capture of the organics.

The spent carbon vessels will be stored on-site. Periodically when a truckload quantity of vessels has accumulated, and at the



conclusion of the vacuum extraction program, the vessels containing the spent carbon will be transported in accordance with applicable federal, state and local requirements to an off-site facility where the carbon will be regenerated by high temperature incineration, and in the process, the organics adsorbed on the carbon will be destroyed.

### **Air Injection System**

The exhaust air from the secondary carbon bed will be piped to the injection pump located in the extraction module building. The injection pump will be capable of delivering 500 SCFM at 10 psig (1.65 atm). The discharge from the injection pump will be distributed to the 26 injection wells via a system of manifolds. Control of the injection pump will be interlocked with the vacuum extraction pump. The pipe at each injection trench will be equipped with a pressure/vacuum gauge so that injection pressure at the trench can be periodically monitored.

During the soil vapor extraction program, the injection trenches will be utilized as extraction trenches and vice versa. This can be accomplished by minor above ground manifold piping modifications. It is also planned that as the Cleanup Standards set forth in Table 3-1 below are met for individual trench "areas", the corresponding extraction and injection trenches will be isolated from the extraction and injection operation by closing the shut off valves located at each trench. This will permit the soil vapor extraction system to concentrate on any remaining areas which have not fully achieved the Cleanup Standards specified in Table 3-1, thereby accelerating cleanup of those areas.

### **RCRA Compliant Cover**

The operation of the vapor extraction system will be enhanced by the installation of a RCRA-compliant cover over the entire site. The final cover will be installed to seal the surface during the vapor extraction program. Details of the final cover are presented in Section 2.1.2.

### **Miscellaneous**

- o Each extraction trench is equipped with two sample taps, one on the vacuum pipe and one on the water collection pipe. Each of these taps can be fitted with a sample bottle for the collection of free moisture.
  
- o Electrical service required for the site remediation work will be 3-phase 460 volt. Total electrical demand will be approximately 100 KVA. Power distribution will be to the extraction module building. Operating voltage for the extraction and injection pumps will be 460 volts. A 110 volt supply will be provided for miscellaneous site lighting, equipment, instrumentation and controls. Power distribution to any site construction and office trailers will also be provided.

- o Prior to construction of the trenches, the following activities will be conducted (although not necessarily by the Settling Defendants):
  - 1. The existing buildings will be demolished and disposed of off-site;
  - 2. The existing tanks removed and properly disposed of off-site; and
  - 3. The site will be graded to fill existing depressions and to eliminate any sharp grade changes.
- o As discussed in more detail in Section 3.7 below, if the Cleanup Standards set forth in Table 3-1 are not achieved within 5 years, additional work may need to be implemented (see Section 3.7 for details).

#### 2.1.2 RCRA-Compliant Cover

The RCRA-compliant cover installed over the site will:

- o Prevent contact with underlying soil;
- o Prevent contamination of surface runoff;

- o Reduce the infiltration of water through the soils thereby preventing ground water and subsequent surface water contamination;
- o Enhance the efficiency of the soil vapor extraction system;
- o Promote evapotranspiration;
- o Promote drainage of precipitation away from the site; and
- o Mitigate erosion.

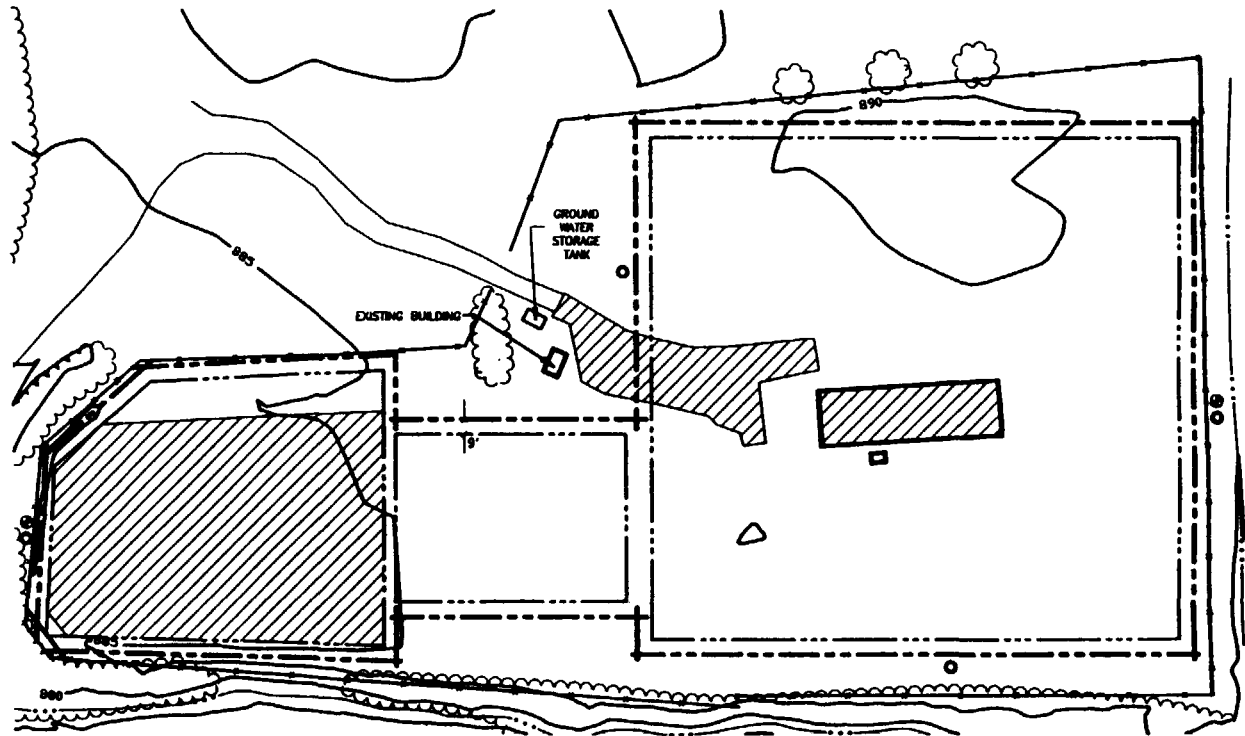
The RCRA-compliant cover will consist of a 1-foot layer of compacted, highly impermeable native soil, a continuous welded 60 millimeter high density polyethylene (HDPE) plastic membrane, a minimum 6-inch layer of compacted sand for drainage, and from 2 to 5 feet of top soil to support vegetation (Figure 2-5). The final grading plan will ensure a minimum slope of 2%. The native soil used will be the silty clay till available in the area, which can and will be compacted by standard methods to a permeability of  $10^{-7}$  or less. If soil from the NSL borrow area is not available, material with similar performance will be obtained from another source.

To provide a perimeter seal of the HDPE membrane, a 3 foot deep "deadman trench" will be installed around the site boundary (Figure 2-6). The HDPE membrane will be draped into this trench. The trench will then be backfilled and compacted with native soil (silty clay till) to a permeability of  $10^{-7}$  or less.

APPROX. SCALE (ft)  
0 25 50 100



LEGEND:	
	FENCE LINE
	BUILDING LINE
	PAVEMENT EDGES
	BOUNDARY LINES
	DEADMAN TRENCH
	DRAINAGE DITCH
	CONCRETE
	SAND & GRAVEL WELL
	FILL WELL



NOTE: "DEADMAN" TRENCH TO BE LOCATED  
APPROXIMATELY 9' BEYOND REMEDIAL  
SITE BOUNDARIES (ALL SIDES)

ENVIRONMENTAL CONSERVATION  
AND CHEMICAL CORPORATION  
ZIONSVILLE, INDIANA  
DEADMAN TRENCHING PLAN

**ERM** ERM-North Central, Inc.

FIGURE NO.

2-6

3/1/89

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As previously described, the material excavated from the trenches will be graded uniformly throughout the trench area and disced into the top 6 to 12 inches of existing surface soil prior to the construction of the final cover detail.

The RCRA-compliant cover will be installed over the entire site, including the concrete pad, prior to initiation of the vapor extraction process. At completion of the soil vapor extraction program all surface piping will be removed from the site in addition to any equipment, buildings or trailers. The extraction and injection trench piping will be cut off at the current grade, filled with grout, and covered with a minimum of 1 foot of topsoil, which will be vegetated. Vegetation which will be established will be characterized by fibrous, shallow, laterally growing roots, such as grass (which may include red fescue and Kentucky blue grass).

#### 2.1.3 Access Restrictions

The objectives of implementing access restrictions are to:

- o Prior to implementation of the RAP, to minimize the potential for contact with any soils and water containing VOCs, base neutral/acid organics, and heavy metals; and
- o Prevent any contaminant migration that might result from future excavation and development.

Access restrictions (which may not be the responsibility of Settling Defendants) will consist of:

- o Fencing around the site perimeter and posting of signs;
- o Filing of appropriate restrictions with the County Recorder's Office prohibiting usage of the site for excavation and development;
- o Filing of appropriate restrictions with the County Recorder's Office prohibiting usage of ground water from the saturated till and the underlying sand and gravel; and
- o Filing of appropriate restrictions with the County Recorder's Office prohibiting installation of new water wells other than monitoring wells.

Ground water use restrictions would be only temporary and will be in place until compliance with the ground water Cleanup Standards in Table 3-1 is achieved and, until such time, will extend to areas where utilization of the shallow ground water could potentially result in contamination being drawn to these locations.

#### 2.1.4 Ground Water and Surface Water Monitoring

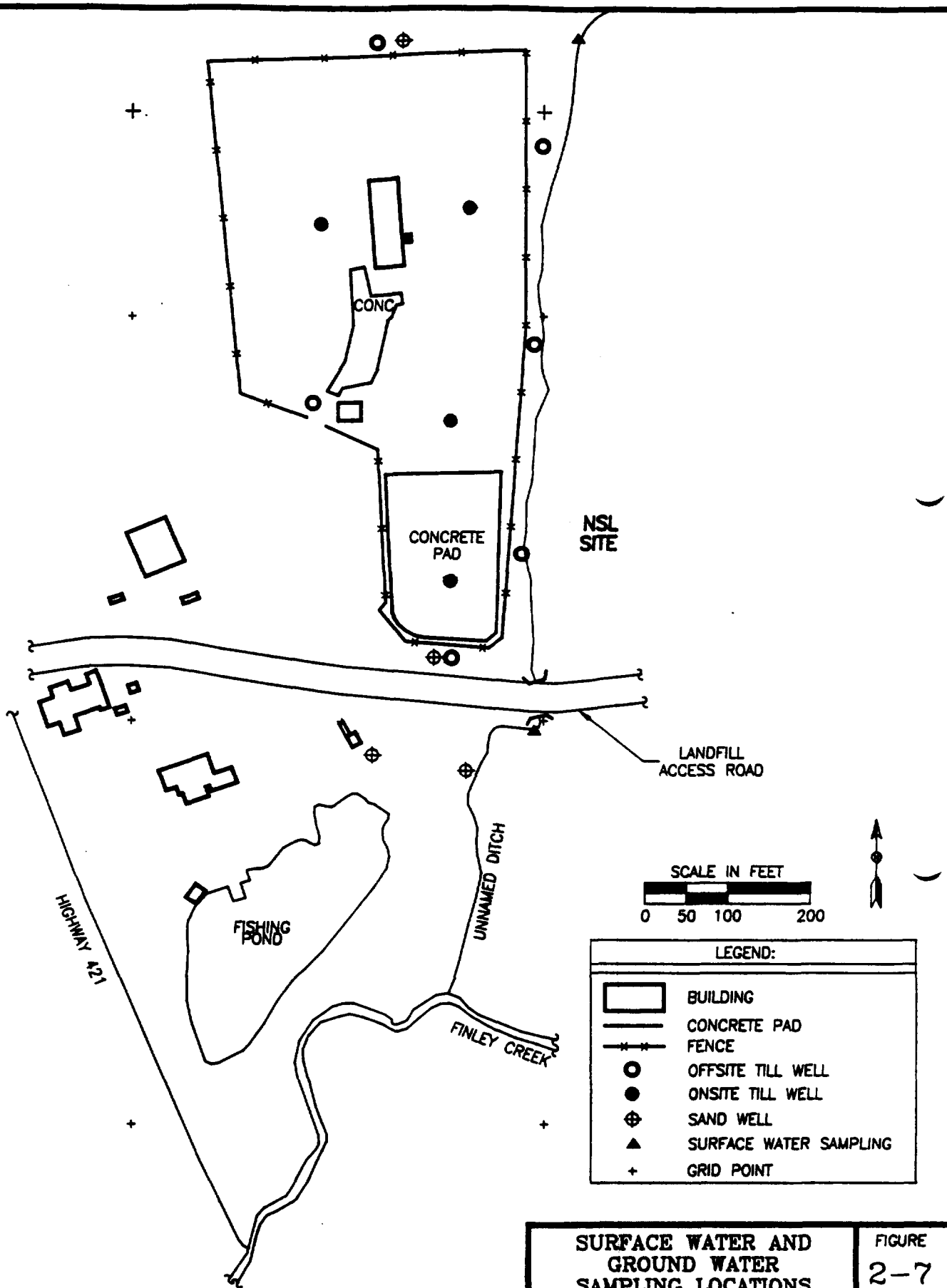
The monitoring activities will:

- o Detect any VOCs migration to the ground water and surface water; and
- o Monitor and verify the effectiveness of the remediation.

Two separate types of ground water monitoring systems will be operated under this RAP. The first is the on-site till monitoring system described in Section 4.0 below; sampling results from those wells will be compared to the ground water Cleanup Standards in Table 3-1 and will be used to calculate soil concentrations for comparison to the soil Cleanup Standards in Table 3-1.

The second type of ground water monitoring system involves off-site wells screened in the till and in the sand and gravel. Sampling results from these wells will also be used to determine compliance within the ground water Cleanup Standards in Table 3-1. This latter ground water monitoring network will consist of ten (10) wells, which will be located around the periphery of and downgradient from the ECC site (Figure 2-7). Six (6) wells will be installed in the till, completed in the saturated zone, and four (4) wells will be completed in the sand and gravel unit underlying the saturated surface till. The wells will be constructed of 2-inch PVC pipe. Screen length will vary for each well. Total depth for the wells completed in the till will be 1-





SURFACE WATER AND GROUND WATER SAMPLING LOCATIONS	FIGURE 2-7
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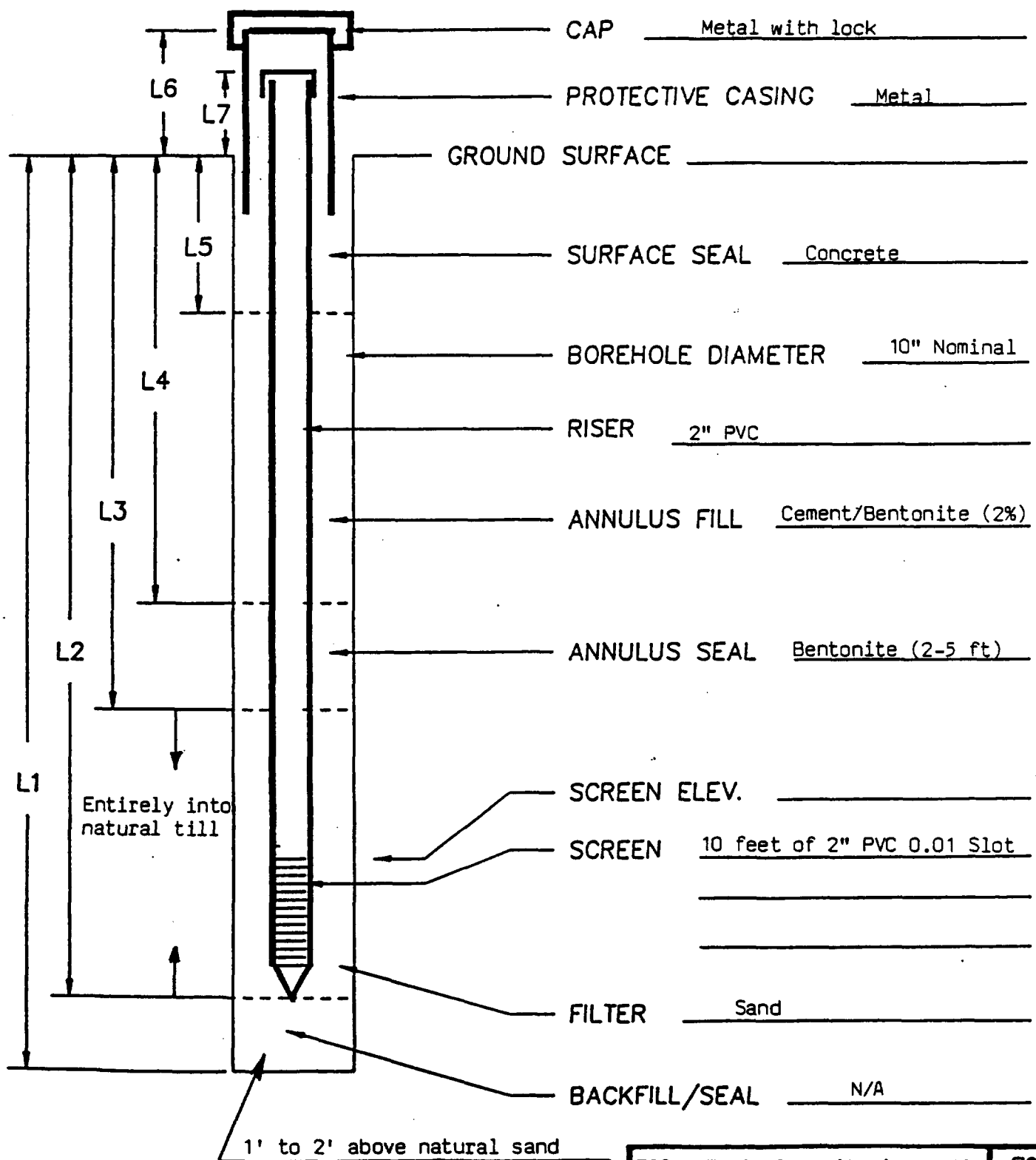
2 feet less than total depth to the contact between the till and underlying sand and gravel. Wells completed in the sand and gravel will screen the total thickness of that sand and gravel unit. Figures 2-8 and 2-9 illustrate well construction details for the ground water monitoring wells in the till and in the sand and gravel, respectively. The location of the monitoring wells is based on the ground water elevation contours shown in Figure 2-10.

Samples from the off-site wells will be collected quarterly during site soil remediation and analyzed for the parameters in Table 3-1. Monitoring will be continued on a semi-annual basis as specified below.

The surface water will be monitored by sampling the Unnamed Ditch just upgradient and just downgradient of the ECC site as depicted in Figure 2-7. Surface water will be sampled at the same frequency as ground water and analyzed for the same parameters.

The semi-annual ground and surface water monitoring called for in this Section 2.1.4 will terminate as follows: As mentioned above, this RAP calls for sampling certain on-site ground water monitoring wells screened in the till. As discussed in Section 4.0, once the laboratory analyses of samples from these on-site till wells in two consecutive, quarterly sampling events lead to the demonstration that the soil Cleanup Standards in Table 3.1 have been met, sampling of the on-site till wells will be discontinued. Once that has occurred, sampling of the off-site wells and surface water under this Section 2.1.4 will be terminated when two consecutive, semi-annual sampling events reveal that none of the Cleanup Standards in Table 3-1 have been exceeded for the appropriate media. If such standards are not

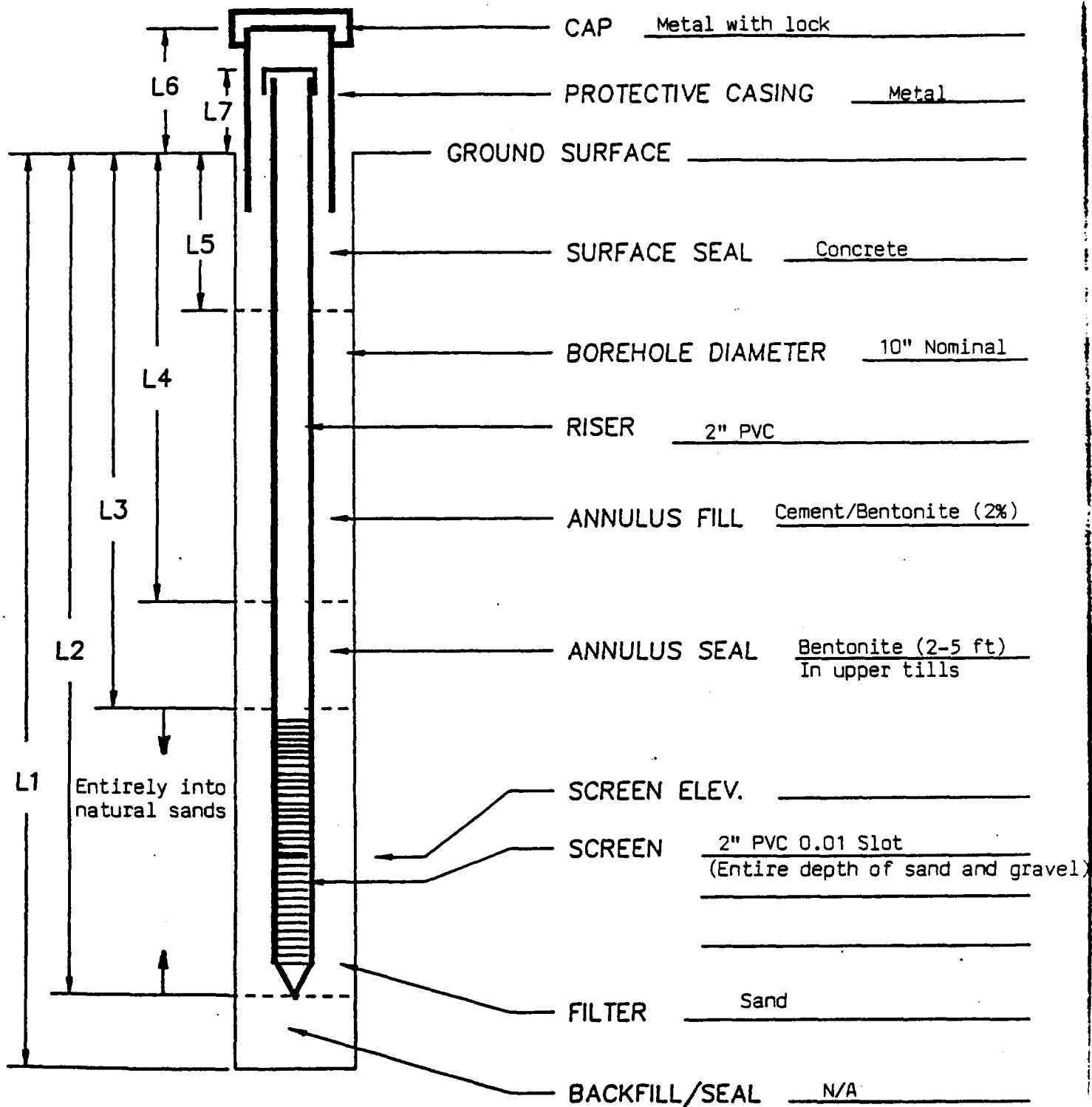
# MONITORING WELL CONSTRUCTION



ECC - Typical Monitoring Well  
Construction Detail  
Well in Glacial Till

FIGURE  
2-8

# MONITORING WELL CONSTRUCTION

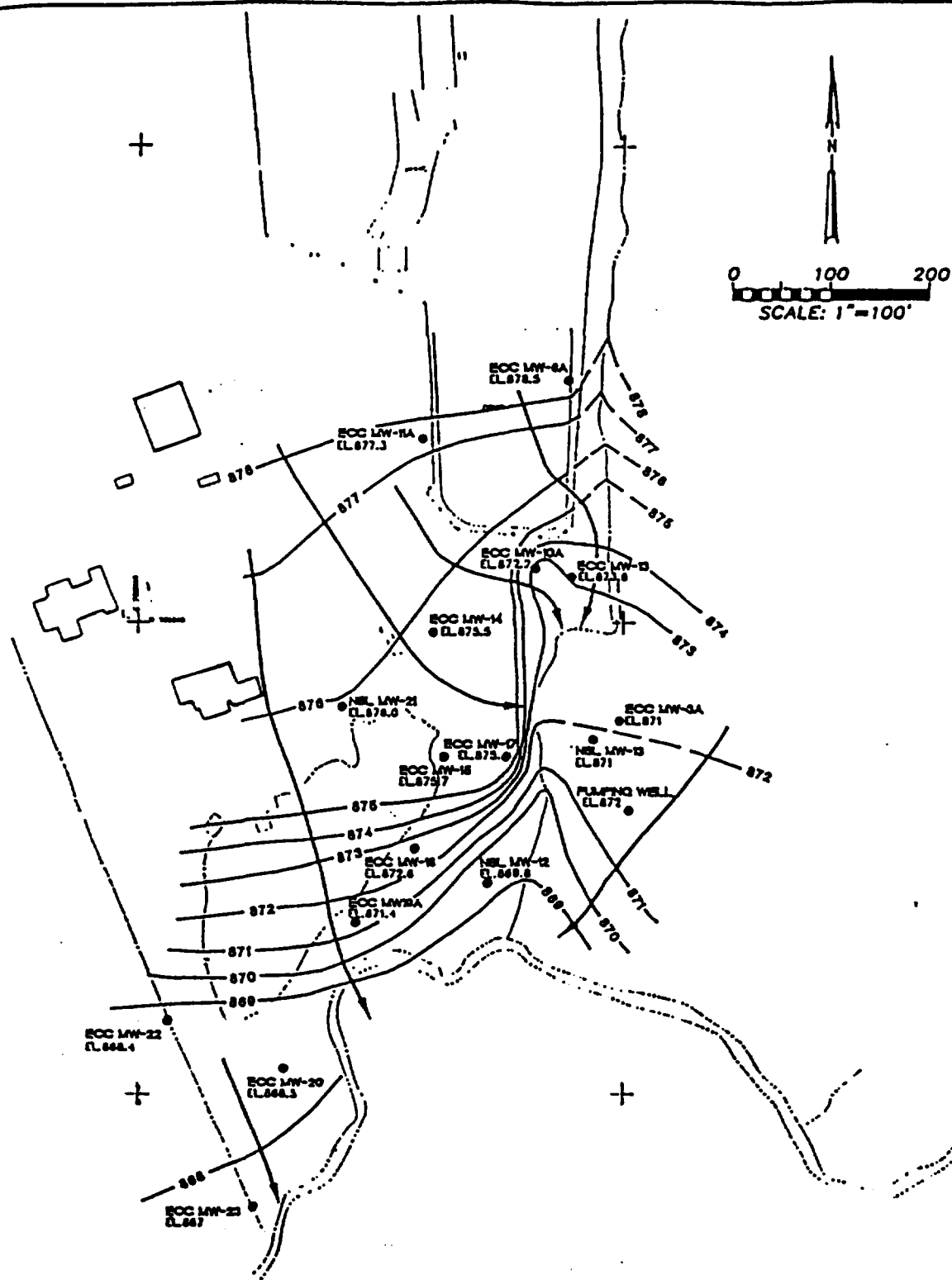


ECC - Typical Monitoring Well  
Construction Detail  
Well in Sand & Gravel

FIGURE

2-9

**ERM** ERM-North Central, Inc.



# LEGEND

- 868 — POTENTIOMETRIC SURFACE CONTOUR FOR SAND AND GRAVEL AQUIFER, CONTOUR INTERVAL: 1 FOOT.
- - - 868 - - - INFERRED POTENTIOMETRIC SURFACE CONTOUR
- >— DIRECTION OF GROUNDWATER MOVEMENT IN SURFICIAL AQUIFER

NOTE: Contours have been drawn to suggest that the pond is not hydraulically connected to the sand and gravel aquifer. This relationship has not been fully established.

From CH2M HILL Technical Memorandum No. 2, dated September 16, 1988.

POTENTIOMETRIC SURFACE MAP OF UPPER SAND AND GRAVEL AQUIFER

FIGURE 2-10

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achieved for the on-site till wells, off-site wells, or surface water, then additional monitoring activities under Section 3.7 may need to occur.

### **3.0 REMEDIAL ACTION CLEANUP STANDARDS**

This section presents site-specific Cleanup Standards to be used at the ECC site to determine the end point of remediation activities and to accomplish clean closure of the site. Achieving these standards will result in the cleanup of the soil and ground water at the site so that without any further remedial action thereafter, the site will not adversely affect any environmental media, including ground water, surface water, or the atmosphere, and so that direct contact through dermal exposure, inhalation, or ingestion will not result in a threat to human health or the environment. As discussed in Section 3.7 below, if these standards are not achieved in 5 years, then alternative Additional Work as described in Section 3.7 may need to be undertaken.

Sections 3.1 through 3.6 describe the standards to be met to achieve a clean closure.

#### **3.1 Cleanup Standards**

To accomplish clean closure of the site, the following Cleanup Standards will be met:

- o Soil concentrations will not exceed the soil levels shown in Table 3-1;

TABLE 3-1 (Page 1 of 2)  
 SITE-SPECIFIC CLEANUP STANDARDS  
 ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION (ECC) SITE

Compounds	Acceptable Ground Water Concentration (1)		Acceptable Stream Concentration (2)		Acceptable Soil Concentration	
	(ug/l)		(ug/l)		Value (ug/kg)	Method
VOLATILE ORGANICS (VOCs):						
Acetone	3,500	RB			490	(3)
Chlorobenzene	1,050	RB			177,000	(3)
Chloroform	100	MCL	15.7		2,300	(3)
1,1-Dichloroethane	0.38	RB			5.7	(3)
1,1-Dichloroethene	7	MCL	1.85		120	(3)
Ethylbenzene	3,500	RB	3,280		1,200,000	(3)
Methylene Chloride	4.7	RB	15.7		20	(3)
Methyl Ethyl Ketone	1,750	RB			780	(3)
Methyl Isobutyl Ketone	1,750	RB			8,900	(3)
Tetrachloroethene	0.69	RB	8.85		130	(3)
Toluene	10,500	RB	3,400		1,250,000	(3)
1,1,1-Trichloroethane	200	MCL	5,280		7,200	(3)
1,1,2-Trichloroethane	0.61	RB	41.8		22	(3)
Trichloroethene	5	MCL	80.7		240	(3)
Total Xylenes	70,000	RB			31,000,000	(3)
BASE NEUTRAL/ACID ORGANICS:						
Bis(2-ethylhexyl)phthalate	2.5	RB	50,000		50,000	(4)
Di-n-Butyl Phthalate	3,500	RB	154,000		8,500,000	(4)
Diethyl Phthalate	28,000	RB	52,100		11,300,000	(3)
Isophorone	8.5	RB			52	(3)
Naphthalene	14,000	RB	620		3,480,000	(3)
Phenol	1,400	RB	570		9,800	(3)
INORGANICS:						
Antimony	14	RB			500,000	(5)
Arsenic	50	MCL	(6)		97,000	(5)
Barium	1,000	MCL			5,000,000	(5)
Beryllium	175	RB			7,000	(5)
Cadmium	10	MCL			10,000	(5)
Chromium	50	MCL	11		1,500,000	(5)
Lead	50	MCL	10		700,000	(5)
Manganese	7,000	RB			7,000,000	(5)
Nickel	700	RB	100		700,000	(5)
Silver	50	MCL			5,000	(5)
Tin	21,000	RB			20,000	(5)
Vanadium	245	RB			500,000	(5)
Zinc	7,000	RB	47		2,000,000	(5)
Cyanide	700	RB	5.2		1,700,000	(4)
PESTICIDES/PCBs:						
PCBs					10,000	(7)

TABLE 3-1 (Page 2 of 2)

NOTES:

- (1) MCL = Drinking water Maximum Contaminant Level. 40 CFR 141.  
RB = risk-based standard. U.S. EPA, Draft RCRA Facility Investigation Guidance, 1987.
- (2) Stream Criteria, from Table 1 of the Record of Decision for the site, September 25, 1987.
- (3) Acceptable soil value is based on ingestion of ground water at the site boundary, assuming a dilution of leachate to ground water of 1:196 (Appendix B).
- (4) Acceptable soil value is based on ingestion of soil, assuming an ingestion rate of 0.2 grams of soil per day by a 17 kilogram child, as per the RCRA Facility Investigation Guidance and the EPA Memorandum on Interim Final Guidance for Soil Ingestion Rates.
- (5) Upper limit of background concentrations listed in U.S. Geological Survey, Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States, Professional Paper 574-F, 1975.
- (6) Value in Table 1 of the ROD is below treatability and detection limits.
- (7) 40 CFR Part 761.125 . Polychlorinated Biphenyls Spill Cleanup Policy Rule.



- o Surface water concentrations from (ECC in Unnamed Ditch south of the site) above the levels shown in Table 3-1 will be prevented; and
- o Ground water concentrations above the levels shown in Table 3-1 in the till and sand and gravel monitoring wells will be prevented.

### 3.2 Calculation of Cleanup Standards

Table 3-1 lists the Cleanup Standards. The equations for calculation of the risks, supporting data and complete references are included in Appendix B.

The calculation of risk-based concentrations shown in Table 3-1 follows the procedures presented in the USEPA Draft RCRA Facility Investigation (RFI) Guidance, July, 1987, and in the USEPA Memorandum on Interim Final Guidance for Soil Ingestion Rates, January 27, 1989. The assumed ingestion rates for soil are either 0.1 grams of soil per day for a 70 kilogram person for 70 years (for compounds with potency factors) or 0.2 grams of soil per day for a 17 kilogram child for 5 years (for compounds with reference doses). The ingestion rate for ground water is 2 liters of water per day by a 70 kg person for 70 years.

Three columns of data, corresponding to ground water, surface water, and soil Cleanup Standards, are presented in Table 3-1. Ground water concentrations are based on either the drinking water Maximum Contaminant Level (MCL) or the appropriate risk-based concentration. These limits assume, as a worst case, that

the ground water in the till could be utilized as a lifetime source of drinking water. However, the use of the ground water in the till as a source of drinking water was rejected as infeasible in the ECC Remedial Investigation (RI), page 6-22. As a result, the use of drinking water standards and risk-based standards based upon daily, long-term human consumption of the till water for Cleanup Standards under this RAP represents an extremely conservative assumption when the real-life risks presented by the ECC site are considered.

Surface water concentrations are taken from the Record of Decision (ROD) for the site, dated September 25, 1987.

Soil concentrations are selected in the following order: (1) regulated cleanup level, such as for PCBs; (2) background concentrations, such as for metals; or (3) lowest of the risk-based concentrations for soil or ground water ingestion.

Table 3-2 presents the compounds detected in soils at the site at levels above the Cleanup Standards specified in Table 3-1. Table 3-3 shows the vapor pressure and solubility of these compounds.

### 3.3 Volatile Organics (VOCs)

The vapor extraction system to be installed at the site will reduce the current VOCs soil concentrations to the levels shown in Table 3-1. VOC concentrations in ground water in the till and sand and gravel will also be reduced to the levels specified in Table 3-1 by eliminating the source of VOCs, and by extracting ground water from the till in the zone of treatment during the vapor extraction activities.

TABLE 3-2  
COMPOUNDS DETECTED IN THE SOIL AT CONCENTRATIONS  
ABOVE THE SITE-SPECIFIC SOIL CLEANUP STANDARDS

Compound	Soil Concentration (ug/kg)	
	Cleanup Standard	Maximum Detected Concentration
VOLATILE ORGANICS (VOCs):		
Acetone	490	650,000
Chloroform	2,300	2,900
1,1-Dichloroethane	5.7	35,000
1,1-Dichloroethene	120	380
Ethylbenzene	1,200,000	1,500,000
Methylene Chloride	20	310,000
Methyl Ethyl Ketone	780	2,800,000
Methyl Isobutyl Ketone	8,900	190,000
Tetrachloroethene	130	650,000
Toluene	1,250,000	2,000,000
1,1,1-Trichloroethane	7,200	1,100,000
1,1,2-Trichloroethane	22	550
Trichloroethene	240	4,800,000
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	50,000	370,000
Isophorone	52	440,000
Phenol	9,800	570,000
PESTICIDES/PCBs:		
PCBs	10,000	39,000
INORGANICS:		
Cadmium	10,000	27,000

TABLE 3-3  
CHEMICAL PROPERTIES OF COMPOUNDS  
DETECTED IN THE SOILS ABOVE CLEANUP STANDARDS

Compound	Solubility (ug/l)	Vapor Pressure (mm Hg)
-----		
VOLATILE ORGANICS (VOCs):		
Acetone	1,000,000,000	270
Chloroform	8,200,000	151
1,1-Dichloroethane	5,500,000	182
1,1-Dichloroethene	2,250,000	600
Ethylbenzene	152,000	7
Methylene Chloride	20,000,000	362
Methyl Ethyl Ketone	268,000,000	77.5
Methyl Isobutyl Ketone	17,000,000	6
Tetrachloroethene	200,000	17.8
Toluene	535,000	28.1
1,1,1-Trichloroethane	4,400,000	123
1,1,2-Trichloroethane	4,500,000	30
Trichloroethene	1,100,000	57.9
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	1,300	0.0000002
Isophorone	12,000	0.38
Phenol	93,000,000	0.341
PESTICIDES/PCBs:		
Aroclor-1232	1,450	0.00406
Aroclor-1260	2.7	0.0000405

REFERENCES:

U.S. EPA, Superfund Public Health Evaluation Manual, 1986.

U.S. EPA, Water-Related Environmental Fate of 129 Priority Pollutants, December 1979.

### 3.4 Base Neutral/Acid Organics

With the vapor pressures shown in Table 3-3, isophorone and phenol will be reduced to acceptable levels by the vapor extraction system.

Bis(2-ethylhexyl)phthalate (EHP) will not be significantly extracted by soil vapor extraction due to its low vapor pressure (see Table 3-3). However, EHP does not and will not present any risk to human health or the environment. First, EHP was only detected in 8 of 35 samples at the site. Second, EHP is easily biodegraded under aerobic conditions, with a half life of about two weeks (USEPA, Water-Related Environmental Fate of 129 Priority Pollutants, December, 1979). The vapor extraction system to be implemented by Settling Defendants will create an aerobic environment conducive to accelerated biodegradation of EHP even beyond that which may have occurred since the RI samples were taken in 1984. Third, EHP has a high affinity for organic carbon in soil. As a result, any amount of EHP that may remain in the soil is unlikely to adversely impact ground water because it will be chemically fixed to the soil and because the RCRA-compliant cover will substantially reduce (by 99%) infiltration through the soil. The RCRA compliant cover will also eliminate any potential for risk from any possible contact with or migration of EHP. Finally, the ground water and surface water Cleanup Standards that are part of this RAP will ensure that ground water and surface water are protected from adverse impacts.

As a result of the comprehensive remedy to be implemented by Settling Defendants, no route of exposure (air, ground water, surface water, or direct contact/ingestion) will create a risk to human health or the environment.

### 3.5 Pesticides/PCBs

Due to their low vapor pressures (Table 3-3), the PCBs will also not be removed by vacuum vapor extraction. However, PCBs also will not present any risk to human health or the environment. First, PCBs were detected above the soil Cleanup Standards at only one location (TP-9, 1-2') and only detected at any level in 6 of 35 soil samples collected at the site. It is also noteworthy that PCBs have never been detected in any ground water monitoring wells at and around the site. Second, PCBs have an extremely low solubility and a very high affinity for organic carbon in soil and are, therefore, chemically fixed to the soil and immobile at the site. As a result, any amount of PCBs remaining in the soil is unlikely to adversely impact ground water. Moreover, the RCRA-compliant cover will substantially reduce (by 99%) infiltration through the soil thereby further protecting the environment. Finally, the RCRA-compliant cover will eliminate any potential for risk from any possible contact with or migration of PCBs.

As a result of the measures to be implemented by Settling Defendants, no route of exposure (air, ground water, surface water, or direct contact/ingestion) will create a risk to human health or the environment.

### 3.6 Inorganics

Cadmium was the only inorganic compound detected at the site at concentrations above the respective Cleanup Standards specified in Table 3-1. However, cadmium also does not and will not present any risk to human health or the environment. First, and like PCBs, cadmium was only detected above the cleanup standards at one location (TP-8, 2.5-4'). Second, cadmium was only detected in 6 of 36 soil samples collected at the site for inorganics analysis. Third, cadmium is an element which occurs naturally in the environment; its presence likely results from natural weathering processes of soil in the environment. Fourth, any amount of cadmium remaining in the soil is unlikely to adversely impact ground water because the RCRA compliant cover will substantially reduce (by 99%) infiltration through the soil. Fifth, the RCRA compliant cover will eliminate any potential for risk from any possible contact with or migration of cadmium. Finally, the ground water and surface water cleanup standards that are part of this RAP will ensure that ground water and surface water are protected from adverse impacts. As a result, no route of exposure for cadmium (air, ground water, surface water, or direct contact/ingestion) will create a risk to human health or the environment.

### 3.7 Additional Work

If Additional Work is required under Section VII of the Consent Decree, Settling Defendants shall either perform such Additional Work as the Parties may agree or shall arrange with a Contractor to perform the following additional work at the site:

- o The RCRA-compliant cover will be maintained and access and land use restrictions will remain in effect.
- o If ground water beneath the site exceeds the Cleanup Standards in Table 3-1, a ground water interception trench will be constructed around the south and east sides of the ECC site as depicted in Figures 3-1 and 3-2.
- o Ground water that exceeds the Cleanup Standards in Table 3-1 will be collected in this trench, pumped out and transported to the Indianapolis POTW (via the NSL pipeline or tank truck), or to such other facility, for appropriate handling and treatment in accordance with federal, state and local requirements.
- o Ground water will continue to be collected and treated in this manner until two consecutive, semi-annual ground water samples collected from the trench show that the ground water Cleanup Standards in Table 3-1 have been met unless the Parties to the Decree otherwise agree or the Court orders that said remedial action may be terminated.
- o Semi-annual ground water sampling and monitoring will continue so long as ground water continues to be collected.

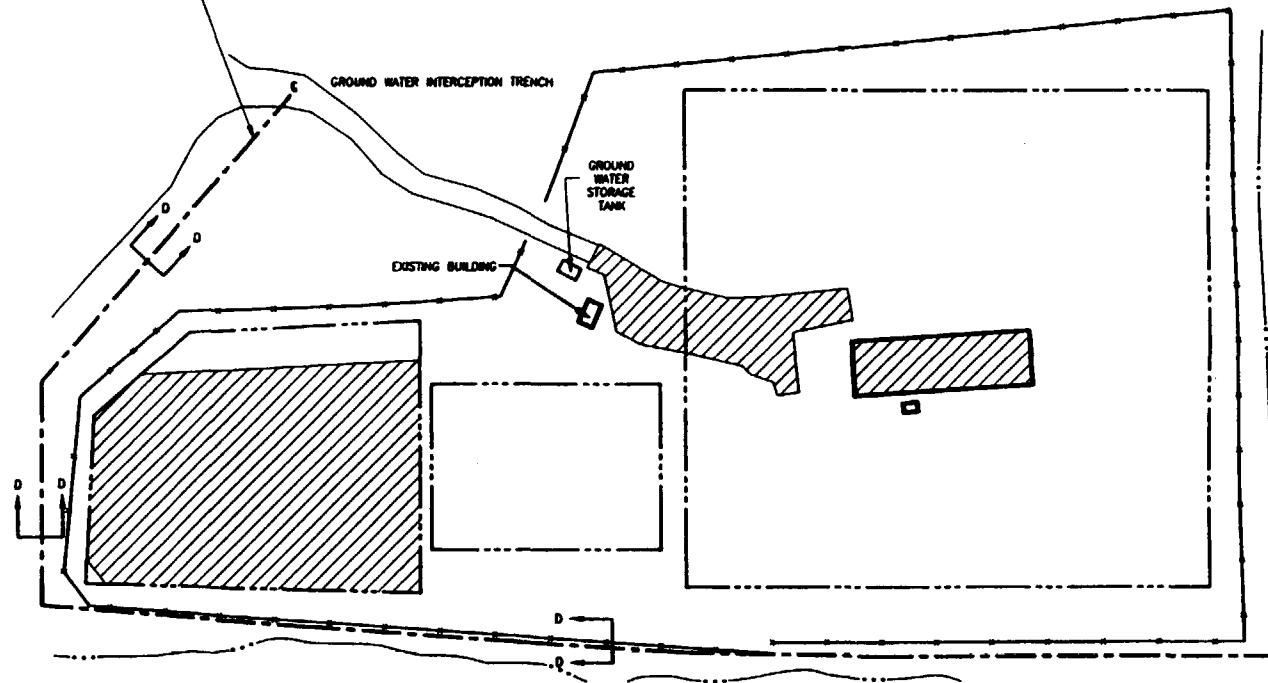


NOTE: DEPTH OF TRENCH WILL VARY  
DEPENDING ON DEPTH OF GLACIAL  
TILL LAYER. BOTTOM OF TRENCH TO  
BE LOCATED ~1'-0" ABOVE  
UNDERLYING GLACIAL SAND.

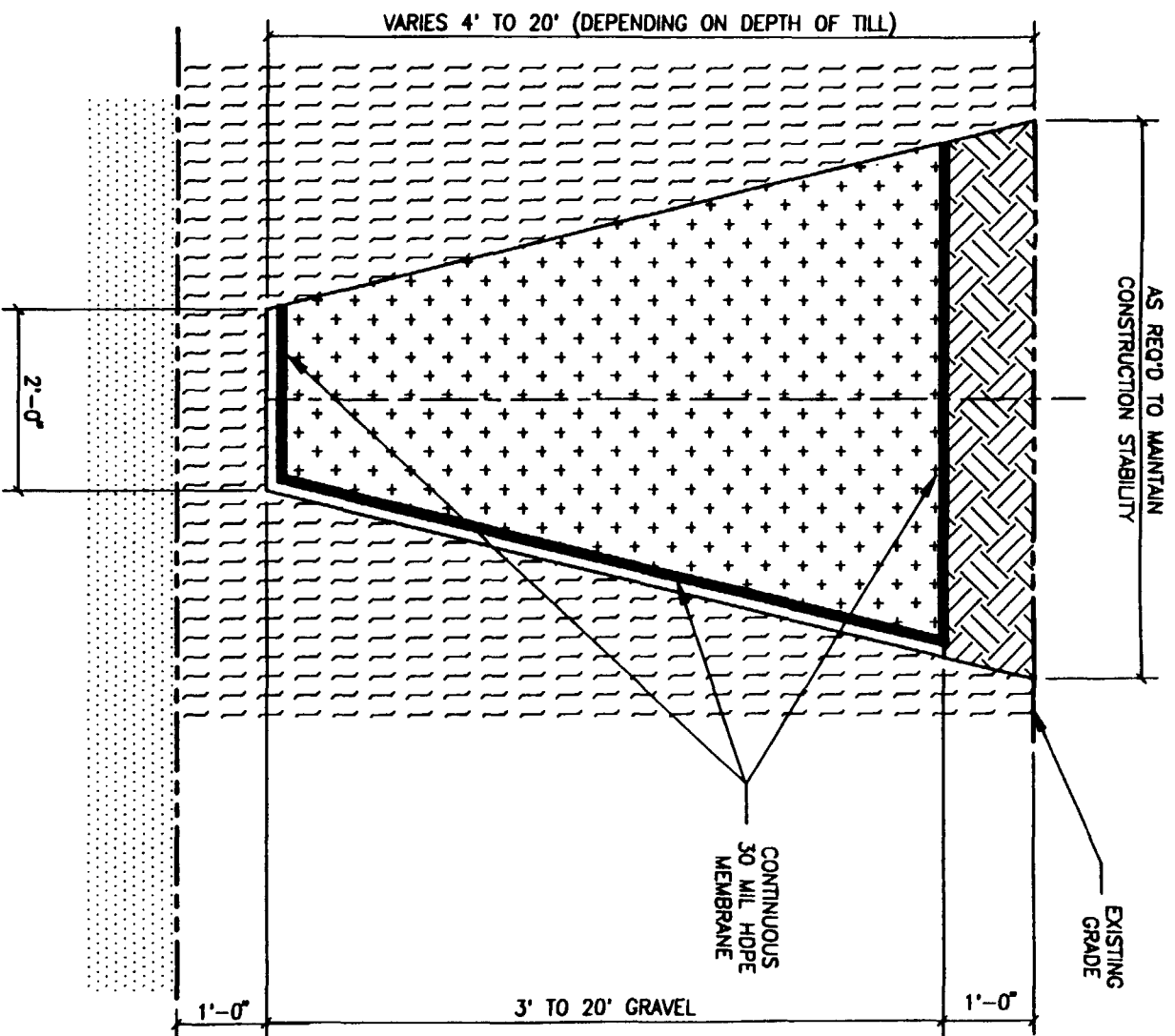
APPROX. SCALE (ft)  
0 25 50 100








LEGEND:	
	FENCE LINE
	BUILDING LINE
	PAVEMENT EDGES
	BOUNDARY LINES
	DRAINAGE DITCH
	CONCRETE
	GROUND WATER INTERCEPTION TRENCH



<b>ERM</b> ENVIRONMENTAL CONSERVATION AND CHEMICAL CORPORATION ZIONSVILLE, INDIANA GROUND WATER INTERCEPTION TRENCH	FIGURE NO.
	3-1
	3/2/89
	mo



LEGEND:	
	COMPACTED NATIVE SOIL
	WASHED FLOAT STONE
	SAND
	GLACIAL TILL
	30 MIL HDPE COVER

GROUND WATER INTERCEPTION TRENCH CROSS-SECTION		FIGURE
ERM - North Central, Inc.		3-2
3/1/89		CS

Nothing in this Section 3.7 shall prevent the Settling Defendants from undertaking additional work under this section before the expiration of the 5 year period should it become evident that the vapor extraction system will not achieve the Cleanup Standards in Table 3-1.

#### 4.0 REMEDIAL ACTION COMPLIANCE MONITORING

Remedial action compliance monitoring within the site (i.e., attainment of soil concentrations specified in Table 3-1) is presented below.

Enhanced volatilization of compounds is designed to achieve the required removals of VOCs, phenol and isophorone as presented in Appendix C. The time required to accomplish this removal depends on the type of compound and soil, air flow rate and temperature, and on an efficient diffusion of air through the soil pores. Therefore, both estimation of the time required for treatment using vapor extraction models (Appendix C) and surrogate analyses, as shown herein, will be used to determine the duration of vapor extraction operation.

The two surrogate analyses to be used to verify that acceptable soil concentrations have been reached are extracted vapor analysis and on-site till water analysis. The only media that come into contact with the on-site soils are air and water. Sampling the extracted air and till water provides an accurate, efficient and effective method of assaying what concentrations are left in the soil. An additional benefit is that these methods can be accomplished while preserving the integrity of the RCRA- compliant cover to be placed on the site. As the only

media that come in contact with the soil will meet the Table 3-1 soil Cleanup Standards, then any concentrations that theoretically could remain in the soil: (1) are not capable of migrating; (2) cannot, by definition, result in a hazard to the air or ground water; and (3) are effectively isolated from contact and exposure by the cover.

#### 4.1 Vapor Extraction Model

A computer model which simulates the vapor extraction system was used to estimate the time required for removal of the maximum detected soil concentrations to acceptable soil cleanup standards specified in Table 3-1. Appendix C summarizes the characteristics of the model and the data used. The air flow rate was proportionately reduced from the total flow of 500 SCFM, using the ratio of length of element to total length of trench, and conservatively assuming an efficiency ratio for the operation of 15 percent. Based on the model results, it is expected that after one year of operation, all the VOCs, as well as phenol and isophorone, will be below the soil Cleanup Standards in Table 3-1 in a "worst case" soil element which contains all the compounds at their maximum detected concentrations.

#### 4.2 Extracted Vapor Analysis

The vapor extraction system will be capable of providing vapor samples from each individual extraction trench as well as from the combined air flow.

The combined air flow will be sampled daily during the first week of operation, weekly for the following 4 weeks, and monthly thereafter. Samples will be analyzed for the VOCs of concern

(Table 3-1), phenol and isophorone. Also, air flow rate will be monitored and recorded, to provide sufficient data to calculate the mass of organics removed from the soils and the effectiveness of the system. These data will also aid in estimating the treatment time remaining, based on the organics mass rate extracted per day.

Air samples from individual extraction trenches will be collected at the beginning of the vapor extraction system operation to establish a baseline of organics removal per trench. These samples will be analyzed for the VOCs of concern (Table 3-1), phenol and isophorone. Once the mass rate extracted per day is reduced to 5 percent of the initial week's rate, additional samples of individual trenches will be collected every three months, to determine when individual extraction trenches can be shut down. The criterion for shutting down individual trenches will be that two consecutive air samples from an individual trench show vapor concentrations to be in equilibrium with the soil Cleanup Standards in Table 3-1.

#### 4.3 Till Water Analysis

Till water within the zone of soil vapor extraction treatment will be collected from four monitoring wells completed in the till. The wells will be 2-in. PVC and will be screened from one foot above trenches bottom to 1-2 feet above the contact between the till and underlying sand and gravel. Screens will have 0.01 inch openings. The wells will have a sand pack to one foot above the top of the screen and a bentonite grout to ground surface.

Samples of the till water will be collected at the beginning of the soil vapor extraction operation, and every three months

thereafter. Every time till water is to be collected, the vapor extraction system will be shut down, to allow water to stabilize within the till. Samples will be collected and analyzed for the VOCs of concern (Table 3-1), phenol and isophorone. These results will then be used to calculate soil concentrations (as presented in Appendix B, Table B6). During construction of these monitoring wells, soil samples will be collected from 1 to 9 feet below the existing surface at 2-foot intervals and analyzed for organic carbon content to provide site specific verification of design calculations.

#### **5.0 MISCELLANEOUS PROVISIONS AND SCHEDULING**

Attached to this Exhibit A as Appendices D, E, and F are the Health and Safety Plan, the Quality Assurance Project Plan, and the Field Sampling Plan, respectively, which provide additional details on how the work described in earlier sections of this Document will be accomplished.

Additional future activities will consist of preparing a document package for EPA and State review that will include appropriate construction contract specifications to facilitate competitive bidding by potential contractors. This document package will be submitted to EPA and the State within six (6) months of the entry of the Decree and prior to the construction of the NSL pipeline.

Figure 5-1 sets forth the Remedial Action Implementation Schedule for implementing the remedy required under the Consent Decree.



<p align="center"><b>REMEDIAL ACTION IMPLEMENTATION SCHEDULE</b></p>	<p><b>FIGURE NO.</b> <b>5-1</b></p>
<p><b>ERM</b> ERM-North Central, Inc.</p>	<p><b>3/1/89</b> <i>me</i></p>

**APPENDIX A**

**ESTIMATE OF MASS OF ORGANICS IN THE SOILS  
TO BE REMOVED BY VAPOR EXTRACTION**



APPENDIX A  
ESTIMATE OF MASS OF ORGANICS IN THE SOILS  
TO BE REMOVED BY VAPOR EXTRACTION

Location	Sampling depth ft	Assumed contamination depth, ft	Total VOCs concentration ug/kg	Mass of VOCs lb
TP-1	1 - 1.5	2	1,972	0.271
TP-2	1 - 1.5	2	28	0.004
TP-3	1 - 1.5	2	108,800	14.978
TP-4	1 - 2	2.5	99,730	17.162
TP-4	2.5 - 3.5	4	4,416	1.216
TP-5	1 - 2	2	24,287	3.343
TP-5	2 - 3	1.5	291	0.030
TP-6	1 - 2	2	12,468,000	1,716.410
TP-6	2 - 3	1.5	22,690	2.343
TP-6	4 - 5	1.5	2,416	0.249
TP-7	1 - 2.5	2.5	267,000	45.946
TP-7	2.5 - 4	2	280,090	38.559
TP-8	1 - 2.5	2.5	3,687	0.634
TP-8	2.5 - 4	2	433,600	59.692
TP-9	1 - 3	3	14,604,000	3,015.694
TP-9	3 - 5	2.5	130	0.022
TP-10	1 - 3	3	958	0.198
TP-10	3 - 5	2.5	432	0.074
TP-11	1 - 3	3	130	0.027
TP-11	3 - 5	2.5	67	0.012
TP-12	1 - 3	3	35,030	7.234
TP-12	3 - 5	2.5	3,609	0.621
SB-01	2.5 - 4	3	3,303	0.682
SB-02	2.5 - 4	3	12,900	2.664
SB-03	2.5 - 4	3	70,070	14.469
SB-04	2 - 3.5	2.5	175	0.030
SB-06	2 - 3.5	2.5	222,010	38.204
SB-08	2.5 - 4	3	3,012	0.622
SB-09	2.5 - 4	3	61,490	12.698
SB-01	5.5 - 7	2	27	0.004
SB-02	5.5 - 7	2	34	0.005
SB-04	5 - 6.5	2	51	0.007
SB-08	7 - 8.5	2	188	0.026
SB-09	5.7 - 7	2	8,069	1.111
TOTAL VOCs, lb				4,995

\* The area contaminated is assumed to be a 25'x25' square around each sampling location. TP = test pit; SB = soil boring.  
Soil concentrations from ECC RI, Section 4.

**APPENDIX B**  
**CALCULATION OF RISK-BASED CLEANUP STANDARDS**

## APPENDIX B

### CALCULATION OF RISK-BASED CLEANUP STANDARDS

The equations used to calculate risk-based concentrations are shown in Table B1. The ingestion rates and acceptable risks are listed in Table B2. The potency factors and reference doses for compounds without any regulatory or background level are from a memorandum from the USEPA Toxics Integration Branch, OERR, Washington, D.C., dated December 19, 1988, with the Corrections to the July, 1988 Update of the Characterization Tables in the Superfund Public Health Evaluation Manual.

Table B3 presents the calculation of risk-based acceptable ground water concentrations in the till for compounds without a regulatory limit (drinking water Maximum Contaminant Level or PCBs Spill Cleanup Policy level). Table B4 shows that the resulting concentrations of compounds at Unnamed Ditch will be below the Stream Criteria presented in Table 1 of the Record of Decision (ROD) for the site, dated September 25, 1987. The dilution obtained from discharge of the ground water in the till to Unnamed Ditch is 1:1800, as presented in Appendix C of the ECC Remedial Investigation. Note that most of the calculated concentrations in the ditch are below detection limits.

Tables B5 and B6 list the acceptable risk-based soil concentrations, based on soil and ground water ingestion, respectively. The calculation of acceptable soil concentrations based on ground water ingestion follows the procedures presented in Appendix C of the ECC RI. Only those compounds without regulatory limit or background levels in soils are listed in Tables B5 and B6. Also, cyanide is not present for lack of an organic carbon/water partition coefficient. It is conservatively

TABLE B1  
EQUATIONS USED TO CALCULATE RISK-BASED CONCENTRATIONS \*

SOIL (concentrations in ug/kg):

$$\frac{\text{Risk} * \text{Body Weight (kg)} * 1000 \text{ (ug/mg)} * 1000 \text{ (g/kg)}}{\text{Ingestion rate (g/d)} * \text{Potency Factor (mg/kg/d)}^{-1}}$$

or

$$\frac{\text{Risk} * \text{Body Weight (kg)} * \text{Reference Dose (mg/kg/d)} * 1000 \text{ (ug/mg)} * 1000 \text{ (g/kg)}}{\text{Ingestion rate (g/d)}}$$

GROUND WATER (concentrations in ug/l):

$$\frac{\text{Risk} * \text{Body Weight (kg)} * 1000 \text{ (ug/mg)}}{\text{Ingestion rate (l/d)} * \text{Potency Factor (mg/kg/d)}^{-1}}$$

or

$$\frac{\text{Risk} * \text{Body Weight (kg)} * \text{Reference Dose (mg/kg/d)} * 1000 \text{ (ug/mg)}}{\text{Ingestion rate (l/d)}}$$

TABLE B2  
INGESTION RATES AND ACCEPTABLE RISKS

INGESTION RATES \* :

SOILS:

0.1 grams per day by a 70-kilogram person for 70 years

or

0.2 grams per day by a 17-kilogram child for 5 years

GROUND WATER:

2 liters of water per day by a 70-kilogram person for 70 years

ACCEPTABLE RISKS:

COMPOUNDS WITH POTENCY FACTORS:

-6  
10

COMPOUNDS WITH REFERENCE DOSES:

1

\* From U.S. EPA, RCRA Facility Investigation Guidance, 1987, and U.S. EPA, Office of Solid Waste and Emergency Response, Memorandum on Interim Final Guidance for Soil Ingestion Rates, January 27, 1989.

TABLE B3  
ECC - ACCEPTABLE HEALTH-BASED GROUND WATER CONCENTRATIONS

Compound (1)	Potency Factor (2) (mg/kg/d)-1	Reference Dose (2) (mg/kg/d)	Acceptable Ground Water Concentration (3) (ug/l)
VOLATILE ORGANICS (VOCs):			
Acetone		0.1	3,500
Chlorobenzene		0.03	1,050
1,1-Dichloroethane	0.091		0.38
Ethylbenzene		0.1	3,500
Methylene Chloride	0.0075		4.7
Methyl Ethyl Ketone		0.05	1,750
Methyl Isobutyl Ketone		0.05	1,750
Tetrachloroethene	0.051		0.69
Toluene		0.3	10,500
1,1,2-Trichloroethane	0.057		0.61
Total Xylenes		2	70,000
BASE NEUTRAL/ACID ORGANICS:			
Bis(2-ethylhexyl)phthalate	0.014		2.5
Di-n-Butyl Phthalate		0.1	3,500
Diethyl Phthalate		0.8	28,000
Isophorone	0.0041		8.5
Naphthalene		0.4	14,000
Phenol		0.04	1,400
INORGANICS:			
Antimony		0.0004	14
Beryllium		0.005	175
Manganese		0.2	7,000
Nickel		0.02	700
Tin		0.6	21,000
Vanadium		0.007	245
Zinc		0.2	7,000
Cyanide		0.02	700

- (1) Only compounds without a regulatory limit (drinking water Maximum Contaminant Level [40 CFR 141] or PCBs Spill Cleanup Policy Rule [40 CFR 761] level) are shown.
- (2) From USEPA Toxics Integration Branch, OERR, Washington, D.C. December 1988 correction to the July 1988 Update of the Risk Characterization Tables in the Superfund Public Health Evaluation Manual.
- (3) Acceptable ground water concentrations calculated using an ingestion rate of 2 liters per day by a 70 kg adult for 70 years.  
Acceptable risk =  $1E-06$  for compounds with potency and 1 for compounds with reference dose.

TABLE B4  
COMPARISON OF SITE-SPECIFIC STREAM CRITERIA  
WITH STREAM CONCENTRATIONS BASED ON NATURAL  
DISCHARGE OF GROUND WATER FROM THE TILL

Compounds (1)	Acceptable Stream Concentration (1) (ug/l)	Concentration at Unnamed Ditch due to Discharge of Till Water at Acceptable Concentrations (2) (ug/l)
VOLATILE ORGANICS (VOCs):		
Chloroform	15.7	0.056
1,1-Dichloroethene	1.85	0.0039
Ethylbenzene	3,280	1.9
Methylene Chloride	15.7	0.0026
Tetrachloroethene	8.85	0.00038
Toluene	3,400	5.8
1,1,1-Trichloroethane	5,280	0.11
1,1,2-Trichloroethane	41.8	0.00034
Trichloroethene	80.7	0.0028
BASE NEUTRAL/ACID ORGANICS:		
Bis(2-ethylhexyl)phthalate	50,000	0.0014
Di-n-Butyl Phthalate	154,000	1.9
Diethyl Phthalate	52,100	15.6
Naphthalene	620	7.8
Phenol	570	0.78
INORGANICS:		
Arsenic	0.0175	0.028
Chromium	11	0.028
Lead	10	0.028
Nickel	100	0.39
Zinc	47	3.9
Cyanide	5.2	0.39

- (1) From Table 1 of the Record of Decision (ROD) for the site, September 25, 1987. Only those compounds detected in ECC soil samples that are listed in this table are shown.
- (2) Assuming a dilution of 1:1800 for natural discharge of till ground water at acceptable concentrations into Unnamed Ditch (from ECC Remedial Investigation, Appendix C).

TABLE B5  
ECC - ACCEPTABLE SOIL CONCENTRATIONS BASED ON SOIL INGESTION

Compounds (1)	Potency Factor (2) (mg/kg/d)-1	Reference Dose (2) (mg/kg/d)	Acceptable Soil Concentrations (3) (ug/kg)	Range of Acceptable Soil Concentrations (4) (ug/kg)
<b>VOLATILE ORGANICS (VOCs):</b>				
Acetone		0.1	8,500,000	850,000-850,000,000
Chlorobenzene		0.03	2,550,000	255,000-255,000,000
Chloroform	0.0061		114,754	11,475-11,475,400
1,1-Dichloroethane	0.091		7,692	769-769,200
1,1-Dichloroethene	0.6		1,167	117-116,700
Ethylbenzene		0.1	8,500,000	850,000-850,000,000
Methylene Chloride	0.0075		93,333	9,333-9,333,300
Methyl Ethyl Ketone		0.05	4,250,000	425,000-425,000,000
Methyl Isobutyl Ketone		0.05	4,250,000	425,000-425,000,000
Tetrachloroethene	0.051		13,725	1,373-1,372,500
Toluene		0.3	25,500,000	2,550,000-2,550,000,000
1,1,1-Trichloroethane		0.09	7,650,000	765,000-765,000,000
1,1,2-Trichloroethane	0.057		12,281	1,228-1,228,100
Trichloroethene	0.011		63,636	6,364-6,363,600
Total Xylenes		2	170,000,000	17,000,000-17,000,000,000
<b>BASE NEUTRAL/ACID ORGANICS:</b>				
Bis(2-ethylhexyl)phthalate	0.014		50,000	5,000-5,000,000
Di-n-Butyl Phthalate		0.1	8,500,000	850,000-850,000,000
Diethyl Phthalate		0.8	68,000,000	6,800,000-6,800,000,000
Isophorone	0.0041		170,732	17,073-17,073,200
Naphthalene		0.4	34,000,000	3,400,000-3,400,000,000
Phenol		0.04	3,400,000	340,000-340,000,000
<b>INORGANICS:</b>				
Cyanide		0.02	1,700,000	170,000-170,000,000

- (1) Compounds shown are those without a regulatory limit or background level in soils.
- (2) From USEPA Toxics Integration Branch, OERR, Washington, D.C. December 19, 1988 corrections to the July 1988 Update of the Characterization Tables in the Superfund Public Health Evaluation Manual.
- (3) Intake for compounds with potency: 0.1 g of soil/d by 70 kg resident adults.  
Intake for compounds with reference dose: 0.2 g of soil/d by 17 kg resident children.  
Acceptable risks: 1E-06 for compounds with potency; 1 for compounds with reference doses.
- (4) Range shown is for risks of 10-4 to 10-7 for compounds with potency and 1 for compounds with reference doses.



TABLE B6 (Page 1 of 2)

ECC - ACCEPTABLE SOIL CONCENTRATIONS BASED ON GROUND WATER INGESTION AT THE SITE (10-6 RISK)

Compound (1)	Solubility (2) (ug/l)	Log Kow (2)	Kd (3)	Acceptable Ground Water Concentration (4) (ug/l)	Acceptable Leachate Concentration (5) (ug/l)	Acceptable Soil Concentration (6) (ug/kg)
VOLATILE ORGANICS (VOCs):						
Acetone	1,000,000,000	-0.24	0.00071	3,500 RB	686,275	490
Chlorobenzene	466,000	2.84	0.858	1,050 RB	205,882	176,620
Chloroform	8,200,000	1.97	0.116	100 MCL	19,608	2,269
1,1-Dichloroethane	5,500,000	1.79	0.076	0.38 RB	74.5	5.70
1,1-Dichloroethene	2,250,000	1.84	0.086	7 MCL	1,373	118
Ethylbenzene	152,000	3.15	1.75	3,500 RB	686,275	1,202,042
Methylene Chloride	20,000,000	1.25	0.022	4.7 RB	922	20.3
Methyl Ethyl Ketone	268,000,000	0.26	0.00226	1,750 RB	343,137	774
Methyl Isobutyl Ketone	17,000,000		0.02604	1,750 RB	343,137	8,935
Tetrachloroethene	200,000	2.88	0.941	0.69 RB	135	127
Toluene	535,000	2.69	0.607	10,500 RB	2,058,824	1,250,377
1,1,1-Trichloroethane	4,400,000	2.17	0.183	200 MCL	39,216	7,193
1,1,2-Trichloroethane	4,500,000	2.17	0.183	0.61 RB	120	21.9
Trichloroethene	1,100,000	2.29	0.242	5 MCL	980	237
Total Xylenes	198,000	3.26	2.26	70,000 RB	13,725,490	30,970,595
BASE NEUTRAL/ACID ORGANICS:						
Bis(2-ethylhexyl)phthalate	1,300	8.7	621472	2.5 RB	490	304,643,220
Di-n-Butyl Phthalate	13,000	5.2	197	3,500 RB	686,275	134,871,303
Diethyl Phthalate	4,320,000	3.22	2.06	28,000 RB	5,490,196	11,298,207
Isophorone	12,000		0.031	8.5 RB	1,667	51.7
Naphthalene	30,000	3.01	1.269	14,000 RB	2,745,098	3,483,209
Phenol	93,000,000	1.46	0.036	1,400 RB	274,510	9,817

TABLE B6 (Page 2 of 2)

- (1) Compounds shown are those without a regulatory limit or a soil background level. Also, cyanide is not included because a specific  $K_{ow}$  is not available.
- (2) From ECC RI, Table 4-4, and Verschueren, 1983, Handbook of Environmental Data on Organic Chemicals.
- (3) From ECC RI, Table 4-4. Calculated as  $10^{\log K_{ow} \cdot OC}$ , where  $OC$  = organic carbon content = 0.00124. For isophorone and methyl isobutyl ketone, the  $K_d$  is obtained as  $K_d = K_{oc} \cdot OC$ , where  $K_{oc}$  = organic carbon-water partition coefficient, obtained from  $\log K_{oc} = (-0.55 \cdot \log S) + 3.64$  (Exhibit A-1 of the Superfund Public Health Evaluation Manual, 1986).
- (4)  $RB$  = risk-based concentration, from Table B3.  $MCL$  = Maximum Contaminant Level, from Superfund Public Health Evaluation Manual, update of November, 1987.
- (5) Leachate discharge/ground water discharge = 0.0051 (Appendix C of the ECC RI; and reduction of the 7.8 in/yr recharge used in the RI under the current conditions (page 5-8) by 99 percent due to the cap).
- (6) Soil concentration (ug/kg) =  $K_d \cdot$  Concentration in leachate (ug/l).

assumed that the volume of leachate from the soils will be reduced by 99 percent from the 7.8 in/yr used in the RI, by installing the RCRA-compliant cover over the site.

A range of acceptable soil concentrations based on water ingestion using the published ranges for organic carbon content of till soils and the SARA range of risk for Superfund site cleanups, is presented in Table B7. The concentrations shown in Table B6 were used to determine the Cleanup Standards specified in Table 3-1, using a risk of  $10^{-6}$  and a soil organic carbon content of 0.12%, as presented in the RI.

Finally, Table B8 presents the complete list of references used for the calculation of the proposed Cleanup Standards specified in Table 3-1.

TABLE B7  
ECC - ACCEPTABLE SOIL CONCENTRATIONS BASED ON GROUND  
WATER INGESTION AT THE SITE (RANGE OF RISKS)

Compound (1)	Range of Kd (2)	Acceptable Soil Concentration (3)	
		Range for 10 <sup>-4</sup> risk	Range for 10 <sup>-7</sup> risk
VOLATILE ORGANICS (VOCs):			
Acetone	0.000058-0.0044	40-3,019	40-3,019
Chlorobenzene	0.069-5.24	14,200-1,080,000	14,200-1,080,000
Chloroform	0.0093-0.71	182-13,900	182-13,900
1,1-Dichloroethane	0.0062-0.47	46.2-3,500	0.046-3.50
1,1-Dichloroethene	0.0069-0.52	9.47-714	9.47-714
Ethylbenzene	0.14-10.7	96,800-7,340,000	96,800-7,340,000
Methylene Chloride	0.0018-0.14	166-12,900	0.166-12.9
Methyl Ethyl Ketone	0.00018-0.014	61.8-4,800	61.8-4,800
Methyl Isobutyl Ketone	0.0021-0.16	721-54,900	721-54,900
Tetrachloroethene	0.076-5.78	1,028-78,200	1.03-78.2
Toluene	0.049-3.72	101,000-7,660,000	101,000-7,660,000
1,1,1-Trichloroethane	0.015-1.14	588-44,700	588-44,700
1,1,2-Trichloroethane	0.015-1.14	179-13,600	0.179-13.6
Trichloroethene	0.020-1.52	19.6-1,490	19.6-1,490
Total Xylenes	0.18-13.7	2,470,000-188,000,000	2,470,000-188,000,000
BASE NEUTRAL/ACID ORGANICS:			
Bis(2-ethylhexyl)phthalate	50100-3810000	2,460,000,000-187,000,000,000	2,460,000-187,000,000
Di-n-Butyl Phthalate	15.8-1200	10,800,000-824,000,000	10,800,000-824,000,000
Diethyl Phthalate	0.17-12.9	933,000-70,800,000	933,000-70,800,000
Isophorone	0.0025-0.19	417-31,700	0.417-31.7
Naphthalene	0.10-7.6	275,000-20,900,000	275,000-20,900,000
Phenol	0.0029-0.22	796-60,400	796-60,400

- (1) Compounds shown are those without a regulatory limit or a soil background level. Also, cyanide is not included because a specific K<sub>ow</sub> is not available.
- (2) For a range of organic carbon content of 0.0001 to 0.0019 obtained from: U.S. Department of Agriculture, Soil Classification - A Comprehensive System. Soil Conservation Service, 7th Approximation, 1960. Calculated as presented in Table B6.
- (3) Acceptable soil concentrations at the risk shown (for compounds with potency) for a range of organic carbon content of 0.0001 to 0.0076. Calculated as presented in Table B6.

**TABLE B8**  
**REFERENCES**

CH2MHILL, Environmental Conservation and Chemical Corporation Feasibility Study, December, 1986.

CH2MHILL, Environmental Conservation and Chemical Corporation Remedial Investigation, March, 1986.

USEPA, Office of Solid Waste and Emergency Response, Memorandum on Interim Final Guidance for Soil Ingestion Rates, January 27, 1989.

USEPA, Region V, Record of Decision for Environmental Conservation and Chemical Corporation, and Northside Sanitary Landfill, Zionsville, Indiana, September 25, 1987.

USEPA, Draft RCRA Facility Investigation Guidance, July, 1987, OSWER Directive 9502.00-6C.

USEPA, National Primary Drinking Water Regulations, 40 CFR 141, last amended by 53 FR 37408, September 26, 1988.

USEPA, Polychlorinated Biphenyls Spill Cleanup Policy Rule, 40 CFR Part 761, published in the Federal Register on April 2, 1987.

USEPA, Superfund Public Health Evaluation Manual, October, 1986, PB87-183125 with updates of November 16, 1987 and July, 1988.

USEPA, Toxics Integration Branch, OERR, Washington, D.C., December, 198 Memorandum with Corrections to the July, 1988 Update of the Risk Characterization Tables in the Superfund Public Health Evaluation Manual.

USEPA, Water-Related Environmental Fate of 129 Priority Pollutants, December, 1979 PB80-204381.

US Geological Survey, Background Geochemistry of Some Rocks, Soils, Plants, and Vegetables in the Conterminous United States, Professional Paper 574-F, 1975.

Veschueren, K., Handbook of Environmental Data on Organic Chemicals, 1983.

**APPENDIX C**

**ECC - VAPOR EXTRACTION MODEL**

## APPENDIX C

### ECC - VAPOR EXTRACTION MODEL

This program was written in FORTRAN by Michael C. Marley and George E. Hoag and reported in "Induced Soil Venting for Recovery/Restoration of Gasoline Hydrocarbons in the Vadose Zone," Proceedings, Petroleum Hydrocarbons and Organic Chemicals in Ground Water Conference, Houston, TX, 1984.

The program is based on the concentration of each component in the vapor phase in the soil, using the partial pressure exerted by each compound, as expressed by the following equation:

$$ZT = \frac{VP * X * V * MW}{R * T}$$

where:

ZT = concentration of the component in the vapor phase, mg/l

VP = vapor pressure of compound, mm Hg

X = mole fraction = moles of component/total moles of organics in soil

V = volume of element, liters

MW = molecular weight of component

R = gas constant = 82.4 atm - cm<sup>3</sup>/gmole<sup>o</sup>K

T = temperature = 294.25<sup>o</sup>K

The program uses the finite difference method to calculate the change in number of moles of each component during a small time interval (i) and then recalculate over the next time interval (i+1), using the reduced number of moles resulting from subtracting the change in number of moles calculated for interval i from the number of moles present in the soil at the beginning of interval i.

The program runs for a finite length of time or until all the components are removed. The program was rewritten in BASIC and applied to the ECC site.

Table C-1 shows the chemical data used to run the model. The compounds to be evaluated are those shown in Table 3-2, except for EHP, PCBs, and cadmium, which are not amenable to removal by vapor extraction. The maximum detected soil concentrations were taken from Section 4 of the ECC RI, while the vapor pressure and molecular weight data are from USEPA, Superfund Public Health Evaluation Manual, 1986.

As there was significant variation of compounds concentrations between soil samples at the site, a theoretical block size was chosen. This theoretical soil block is 10 ft x 10 ft x 2 ft deep and was assumed to contain all components of interest at their maximum detected concentrations (Table C-1). Furthermore, it was conservatively assumed that the air flow through the soil would only be 15% efficient in removing the organics. In effect, this represents a worst case estimate of the time required to remove the organics from the soils. The mass of this block was estimated as 10,200 kg.



TABLE C1  
ECC - CHEMICAL DATA OF COMPOUNDS

Compound (1)	Molecular Weight (2)	Vapor Pressure (2) (mm Hg)	Maximum Detected Soil Concentration (3) (ug/kg)
VOLATILE ORGANICS:			
Acetone	58.1	270	650,000
Chloroform	119	151	2,900
1,1-Dichloroethane	99	182	35,000
1,1-Dichloroethene	97	600	380
Ethylbenzene	106	7	1,500,000
Methylene Chloride	85	362	310,000
Methyl Ethyl Ketone	72.1	77.5	2,800,000
Methyl Isobutyl Ketone	100	6	190,000
Tetrachloroethene	166	17.8	650,000
Toluene	92.1	28.1	2,000,000
1,1,1-Trichloroethane	133	123	1,100,000
1,1,2-Trichloroethane	133	30	550
Trichloroethene	132	57.9	4,800,000
BASE NEUTRAL/ACID ORGANICS:			
Phenol	94.1	0.341	570,000
Isophorone	138	0.38	440,000

(1) Compounds shown are those amenable to soil vapor extraction.

(2) From U.S. EPA, Superfund Public Health Evaluation Manual, 1986.

(3) From ECC RI, March 1986.

The air flow rate was estimated as a fraction of the total air flow rate to be used at the site (500 SCFM), based on the length of injection trench influencing the assumed soil block (10 ft) as a ratio of the total length of injection trenches (3,800 ft). This represents an air flow rate of 37.26 liters per minute.

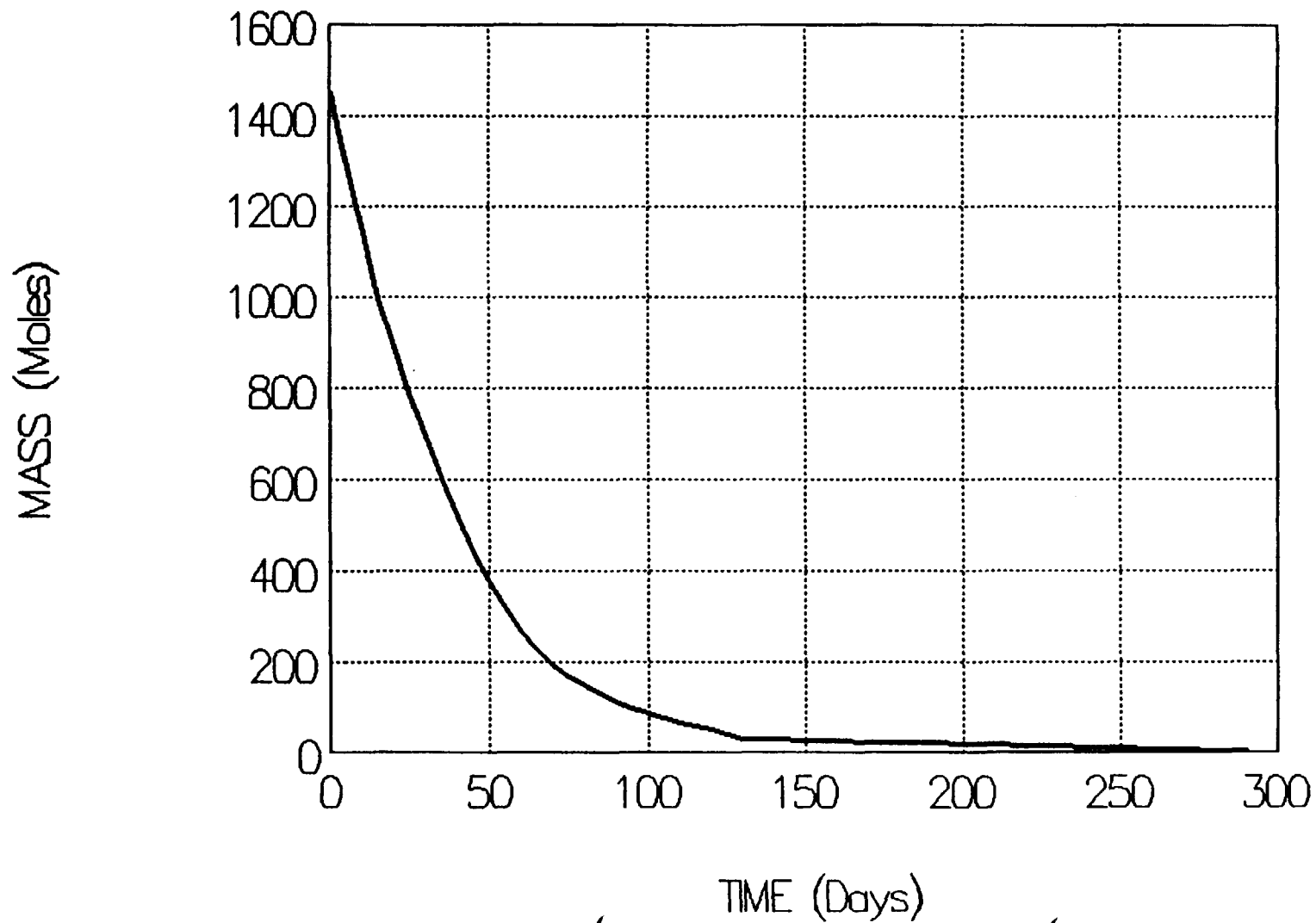
The results, summarized in Figure C1, show that essentially no VOCs will be present in the hypothetical soil element after 130 days of soil vapor extraction. To remove phenol and isophorone to the Cleanup Standards in Table 3-1, operation of the vapor extraction system for a total of approximately 360 days is necessary.

Actual large-scale soil vapor extraction systems have been operated with excellent removals of compounds such as tetrachloroethene, trichloroethene, 1,3-dichloropropene, methyl ethyl ketone, methyl isobutyl ketone, toluene, and xylenes. Some published references are:

- o Lisiecki, J.B., and F.C. Payne. "Enhanced Volatilization: Possibilities, Practicalities, and Performance." Presented at the Engineering Foundation Conference, Mercersburg, PA, August 7-12, 1988.
- o Regalbuto, D.P., J.A. Barrera and J.B. Lisiecki. "In-Situ Removal of VOCs by Means of Enhanced Volatilization." Proceedings of the Conference on Petroleum Hydrocarbons and Organic Chemicals in Ground Water: Prevention, Detection, and Restoration, Houston, TX, November 9-11, 1988.

Figure C1

# ECC VAPOR EXTRACTION MODEL RESULTS



- o Johnson, J.J., and R.J. Sterrett. "Analysis of In-Situ Soil Air Stripping Data." Proceedings of the 5th National Conference on Hazardous Wastes and Hazardous Materials, Las Vegas, Nevada, April 19-21, 1988.

A full-scale vapor extraction system (Lisiecki and Payne, 1988) was able to remove tetrachloroethene from 5,600,000 ug/kg to 17 ug/kg, as found by soil sample analysis, in 280 days. Therefore, both theoretical models and actual results show that the required removals will be accomplished by vapor extraction.